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ABSTRACT

This science curriculum guide for grades K-6 is designed to provide a balance between an understanding of the concepts of science and the development of skills such as observation and classification. It is also designed to help Manitoba schools develop their elementary science programs by providing: (1) a basic core of 32 units which present a sequenced development of concepts and skills, (2) optional units and objectives which provide flexibility to the program, and (3) a listing of recommended materials coordinated for use with core topics. The 32 core topics are outlined in detail together with objectives for students, sample activities, and suggestions for integrating science with other subjects. (Author/CS)

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This guide replaces the Primary Science Guide (1967) and intermediate Science Guide (1968) and the revised interim version issued in 1976. It has been developed as part of an overall revision of science programs for Manitoba schools and is designed to articulate with the proposed guide for grades 7-8-9. The final form is based on the interim document and incorporates the suggestions and input of teachers. Science K-6 (1979) becomes the approved provincial guide for science in kindergarten and elementary school, effective September, 1979.

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Introduction

During the sixties, major changes in the nature, purposes, and approaches to elementary science were developed through the efforts of diverse groups of curriculum innovators, including educators, scientists, and psychologists. Elementary science teachers became concerned with helping children develop skills in scientific processes in addition to a knowledge of concepts.

In addition, activities were designed which related to the developmental level of the child. The need to provide for individual differences among students led to the use of a variety of teaching approaches and materials. At the same time science programs were developed which varied from emphasizing the use of the local environment as a learning laboratory to suggesting means whereby teachers could use students' interests as points of departure for curriculum development. Consequently, teachers and administrators are now making fundamental curriculum decisions based on this wide range of approaches and materials available to schools.

This guide is designed to lend assistance in making decisions concerning curriculum modification in elementary science and reflects a change of emphasis from that of the previous one. It is intended to provide a balance between an understanding of the concepts of science and the development of skills such as observation and classification. It is also designed to help schools develop their elementary science programs by providing: 1) a basic core of thirty-two units which present a sequenced development of concepts and skills, 2) optional units and objectives which provide flexibility to the program, 3) a listing of recommended materials coordinated for use with core topics. The thirty-two core topics are outlined in detail together with objectives for students, sample activities, and suggestions for integrating science with other subjects.

Introduction

An Operational Definition of Science [1]

When you ask . . .
Why are babies born
so small,
Where are their teeth
and hair and all?
What makes them want
to suck their thumb
Why can't they walk, and
jump, and run?
That's science

When you see . . .
That flowers don't grow
when it snows,
That all kites need a
wind that blows,
Some birds are red, some
blue, some brown,
And a wheel, to roll
must be round.
That's science.

When you wonder . . .
Why are robin's eggs so
blue?
Do people lay eggs as
they do?
If birds can fly and
people can't,
Why can't a dog, or cat,
or ant?
That's science.

All the things you want
to know
About yourself and how
you grow,
About the world in which
you live,
What you think, and find,
and give.
That's science.

Science is man's search for truth through a systematic and cumulative exploration of himself as a physical and thinking animal and of the natural phenomena he finds in his universe.

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[1] E. Smith. Adapted from "An Operational Definition of Science". *Science and Children* (March 1974), p. 34-35.

In a more formalized definition, the study of science attempts to impart order to our world by finding related patterns through the use of a variety of skills, techniques, and thought processes. In a seemingly unending process, scientists develop new organizations and more precise definitions of the patterns in order to see the universe as a logically ordered system.

It is the rare teacher who has not met children filled with questions which they need to resolve about their world. Children, too, look for patterns in order to make sense of the many and sometimes contradictory experiences that are being received and processed. How do I relate new ideas to my world? How do I collect this data? These are important questions for the child.

The Role of Science in General Education

Whether it is examining the hardness of a rock, the symmetry of a flight of geese, or the pull of forces on a kite, the child initially examines and probes his environment through concrete experiences within a broad range of interests. One of the important functions science shares with other areas of study is the development of basic processes of classifying, measuring, using space-time relations, inferring, and predicting. The opportunity to formulate and test simple hypotheses, to recognize and control variables, and to assess data through independent or group work assists the student in reasoning and applying order to his world.

The young child lives in and views an integrated world which is not divided by arbitrary divisions of mathematics, history, science, art, and language. The application of this global concept of the child's world has led to many opportunities for integrating subject areas. Only as children develop do they appear to recognize that certain activities and ideas are related to language, art, or science experiences. The following supportive relationships between areas of study are suggested in order to help define a process of integration:

Science and Language Development

" . . . As the child looks, listens, sees, smells, tastes, he becomes an active participant rather than a passive observer. From his experiences, he evolves a frame of reference which will influence the way he expresses himself." [2]

Through interaction with materials in simple activities, small groups of children are able to develop listening, reasoning, and group participation skills. Similarly, the reporting of results through oral, written, and graphic means supports the development of communication skills and introduces children to the use of different methods of communicating the results of their activities. Just as science experiences can evolve from children's interest in a story about a kite, their use of a variety of means of communication can be "sparked" by a science experience.

Science and Mathematics

When a student uses paper clips as a standard unit of measuring, or measures wind dispersal distances of seeds, that's mathematics—or is it science? Estimating, measuring, counting, comparing, averaging, quantifying, graphing, and recording in appropriate ways contribute to a student's understanding of the use of number and measurement.

Science and Social Studies

Children are naturally curious about the physical and social world around them. In both science and social studies children can be helped to see patterns. The content or concepts which students examine and develop may be different in some areas of study. However, questions such as—Why do some plants live in a pond and others do not? *or* Why do people fulfil their basic needs in different ways?—can both be tested by planning investigations and gaining evidence. The skills of observing, assembling data, posing and redefining questions into testable forms, planning investigations, and drawing reasonable conclusions are important to both science and social studies. The differences between these disciplines lie in the relative ease with which children can obtain reliable evidence and in the kinds of questions which can be tested.

Science and Environmental Education

Children are part of a natural and man-made environment. Environmental education is concerned with providing children with opportunities to examine and understand the relationships in this multi-dimensional environment. Thus, studies are made of the community, the ways in which people live or have lived, the utilization of natural resources, and the interdependency of man and the environment. Through their studies, children develop concepts, skills, attitudes, and values which influence their concern for and consequently their behavior towards the environment.

Environmental education is not a separate discipline; rather, it suggests that we use the world around the child to develop those skills, attitudes, and concepts necessary to become knowledgeable about the total environment. The relationship between environmental education and science implies the need for students to examine science problems in an environmental context. Similar concepts may be studied inside and outside the school (e.g., interdependency within an aquarium and within a pond).

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2. E. A. Cannon and G. T. Ladd, "Integrating Science Through Language Arts", *Science and Children* (April 1974), p. 10-11.

A General Program Overview*

Elementary school science programs have changed significantly in recent years. Some parents are puzzled by the requests for old newspapers, containers, and other "junk". Those parents who have visited the school may be shocked and bewildered by the messy, noisy atmosphere which they find in the science class. The activity approach to science education is the "culprit". This approach to science teaching has two underlying premises, both of which are borne out by modern theory, research, and the experiences of classroom teachers: the first premise is that children learn best by doing, that is, by actively manipulating materials and by sharing experiences with their classmates; the second premise is that content learning is secondary to process learning. Content learning, which is the collection of facts, ideas, and the formulation of generalizations, was in the past the primary emphasis of science programs. Process learning includes the development of the "skills of science" such as simple observation and classification and more complex processes of inferring and experimenting. This means that the development of specific skills of science is now the primary goal of science teaching and that memorization of encyclopædic facts has been de-emphasized.

This elementary science curriculum guide is in two parts: part one in an overview which discusses the philosophy, background, and general approach; part two is a detailed outline for the science program in each grade from kindergarten to grade six.

Part one points out that the guide is written using the "process approach" to science education. There are twelve processes or skills to be learned by pupils, beginning with simple observation and progressing to development of all those skills necessary to meaningful experimentation. These processes are outlined in detail on pages 14 and 15 of this guide.

The development of the processes of science may be carried out using a wide variety of topics. For example, classification may be developed using shapes and colours, types of birds, models of automobiles or many other objects or ideas which have differences between them.

In order to provide continuity in the guide and some degree of uniformity throughout the province, the content has been specified for each grade level. This content is based on three "themes" or basic ideas of science:

1. Interdependency and Interaction Among Organisms;
2. Changes in Matter and Energy;
3. Earth, Space, and Time.

A detailed outline of the content material for each grade level is provided in the scope and sequence on pages 39 to 61 of the guide. This material has been developed in thirty-two units of study. Inspection of this outline will provide an appreciation for the sequential treatment of the three themes from kindergarten to grade six.

Other sections in part one of the guide provide information on various commercially prepared curriculum materials which are recommended for use in Manitoba schools. These curriculum materials are compared on page 20 with more detailed information given in the appendices.

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*Schools may find the General Program Overview particularly useful in describing the K-6 Science program to parents.

Part two of the guide is divided into seven sections, one for each grade level (K-6). Specific objectives for pupils are stated and recommended activities are provided along with references to the commercially prepared curriculum materials.

It should be noted that the guide provides no recommendations for the teaching sequence of units within a grade level. Teachers in classrooms are best able to determine which unit will be taught at what time of the school year. Sequencing could depend upon local resources and integration of the science program with other subject areas.

Examination of part two of the guide allows for appreciation of the activity-oriented approach of this program. Developmental theorists have pointed out that young children learn best by doing; this is a basic premise of the whole program.

This brief outline should provide a general understanding of how the guide has been organized and the goals inherent in it. Reading all of part one would lead to a greater depth of understanding.

1. Specific goals have been suggested for each grade level to serve as guidelines. Not every child will necessarily reach these goals at the same time. The goals involve a gradual mastery of and proficiency in various concepts and processes, until total mastery and proficiency is attained.
2. There will be varied groupings of children based on the differing rates of learning and maturation. These will provide for more effective teaching and learning. These groupings will not be permanent but will change throughout the year.
3. Parents may from time to time be requested to assist with collections of concrete materials (real objects) and pictures which will be used in the classroom to make learning experiences more meaningful.
4. Parents wishing to help their children learn should be encouraged to:
   (a) *Discuss* everyday events with the child in a way that encourages questions. Simple events like boiling water in an electric kettle can be made very valuable by discussing sights, sound, and changes associated with the boiling water;
   (b) *Encourage* the child to make his/her own independent investigations. Often children's questions lead into investigations with materials. For example, the child might ask—How hot is boiling water? This question would best be handled by using a thermometer to measure the temperature. The process of measuring would lead to more questions and investigation.

Discussion and *encouragement* will reinforce the child's natural curiosity and provide some of the skills necessary for finding out more about his or her world.

The Developmental Stages of Children

The doing aspect of science programs is closely related to the developmental stages of the child. Many K-6 science programs that have been developed during the past twenty years have been based upon the research of psychologists such as Piaget, Bruner, Ausubel, and Gagne. Although individual theories differ, the emphasis placed on experience with concrete materials and the need for the child to be involved in actively structuring his or her learning are common elements to them all.

The development of the thinking processes is continuous. However, the description of these processes must be divided into arbitrarily chosen sections suggested by characteristics of the developmental process itself. According to Piaget, children pass through an ordered series of developmental stages. These stages are believed to be controlled largely by the maturation of the brain and the nature of a child's experiences. Children can be helped to develop gradually within these stages if stimulating activities suited to their abilities are available for them.

Characteristics of Stages	Appropriate Activities
Pre-operational Thinking *(2 to 6 years)*	
Child is egocentric and cannot readily see points of view of others. Child is in a stage of vocabulary development. Has to do things in order to find out what happens—cannot think out likely consequences (unless it is something he/she has done before). Tends to see one variable at a time and to ignore others. When things are made to look different, they are interpreted as being different even if there is no real change.	Being able to manipulate and carry out physically the actions he/she is unable to carry out mentally. Exploration and experiences of trying things out to see the results enables them to link cause and effect. Repeating an activity several times, if desirable.
Concrete Operational Thinking *(7 to 12 years)*	
Early: Begins to think out what might happen as the result of an action. May notice more than one variable but the ability to see the effect of changing and combining variables is limited. Problem solving is unsystematic; "trial and error". Tests he/she uses are often unfair. Begins to form logical conclusions based on concrete evidence. Develops classification skills by grouping perceptually (one pro-	Exploring a wide range of problems in real situations and gradually coming to see patterns. Planning and carrying out investigations or methods of problem solving which he/she has devised; discussing results and learning from errors about the variables which should be controlled. Putting problems in concrete terms where doing can support thinking.

Characteristics of Stages	Appropriate Activities
perty to using more than one property for class inclusion). Explains in terms of concrete evidence; may use contradictory statements. Later: Greater ability to manipulate things mentally, to plan ahead, and to approach problems systematically. Can develop and use concrete models. An increasing need for and use of measurement and recording; can measure time intervals but has little understanding of continuity of time. Understands area but has difficulty conserving volume. Thinking is limited to thoughts about concrete things of reality to the child; incomplete ability to deal with variables except in simple cases; has difficulty using reversible logic.	
Formal Operational Thinking (13 to 15 years)	
A growing ability to see the relationship of problems and that it is possible to generalize. Makes use of abstract concepts in explaining cause and effect. Thinks in terms of the hypothetical as well as the actual. Recognizes relevant variables in a situation and can control them when testing out the effect of changes.	Drawing conclusions from previous learning and applying principles to new problems. Testing ideas by planning experiments which control all the necessary variables. Developing abstract ideas about properties of materials; devising and using theoretical models for predicting and explaining.

Other factors that should be considered are:

1. The use of formal thought processes increases gradually through the school years, continuing into adulthood;
2. Almost any given child may demonstrate all Piagetian stages on different occasions with different materials or ideas. With new or difficult ideas, a formal thinker may use concrete materials and approaches to the problem;
3. There is reason to believe that the notion of fairness, restricted at first to situations involving only a few and familiar variables, develops into a clear concept of a controlled experiment if students are confronted with reviewing whether certain variables have been controlled in the same way.

Teaching implications

1. The science program must be experienced-based and activity-centred. Concrete experiences are essential for the pre-operational and concrete operational stages. Tasks must not be too difficult for the developmental level or children will become discouraged, e.g., children are not able to hypothesize or control variables until the formal operational stage.
2. Piaget's experiments have shown that children younger than nine or ten are often unable to separate objects into living and non-living. Plants and animals in the classroom can stimulate development of an understanding of what it means to be alive.[3]
3. Young children do not realize that living organisms pass through several stages of development and still remain the same organism, e.g., seeds to plants.[4]
4. Until children are nine or ten, their ideas of natural phenomena are animistic, that is they attribute human feelings to inanimate objects, (e.g., the wind moves because it wants to). Observing natural phenomena is very necessary at this stage.
5. Piaget's research has also indicated the importance not only of "hands-on" activities, but also of peer interaction, questioning, and discussion.
6. The teacher should help the student develop the investigations for himself, learn to ask questions, plan activities and make errors. The teacher stands ready to provide encouragement, overcome frustrations, and build confidence.
7. The understanding of the concept of time develops slowly. At the pre-operational level, the understanding of time is limited to very short periods not distant from the present. At the concrete operational level, the student will likely have an inadequate grasp of time intervals beyond a year or two and will have difficulty with continuity of time and the estimation of time intervals longer than seconds.
8. Children will have difficulty with ideas related to space phenomena because observations will tend to contradict the scientific explanations.

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[3] Ann Howe and Janice Johnson, "Intellectual Development and Elementary Science: Some Implications from Piagetian Research", *Science and Children*, October 1975, p. 30-31.

[4] Ibid.

9. Children should have some control over their own learning, i.e., the program should provide students with opportunities to extend their activities into related or more complex concepts and events which contradict the child's concept. For example, if a student encounters the idea that big objects float, he should have an opportunity to encounter a big object that sinks.

The Affective Domain and the Psychomotor Domain

In presenting a program to elementary level children, the science educator should keep in mind the hierachy of the affective domain The five major categories within this hierarchy are as follows:

1. Receiving: This first level includes an individual's awareness of particular phenomena. A person at this level realizes there is not always sufficient evidence for drawing a definite conclusion. For example, the primary-age student's awareness can be drawn to the many ways in which phenomena interact with each other and the environment;
2. Responding: This level goes beyond simple awareness to making some response. For example, this may involve reading about or engaging in some other form of information gathering. This level might involve a more volunttary commitment to learn;
3. Valuing: This level includes many objectives that have the characteristic of attitude or belief. The behaviour or performance of the student has a consistency or stability that indicates a commitment to certain ideas or values;
4. Organization: Students have established a system of values which are conceptualized or understood in the abstract. Some of the conflicts which have developed in acquiring a value system are now starting to be resolved and interrelationships are being determined again;
5. Characterization: This is the final level of the affective domain and is seldom reached by elementary students. This level involves a person's behaviour determined by certain controlling values, ideas or beliefs and the integration of values and attitudes into a world view or philosophy of life.[5]

At the pre-school and elementary school level, the child is becoming aware of the environment and is learning his role as a member of a family, a school and a community. He is naturally curious, inquisitive, and energetic, and needs to work with concrete materials in his learning experience.

Teaching Implications

1. The program must be experience-centered so that all children are given opportunities to become aware of and work with plants and animals in inquiry situations both inside and outside the classroom.
2. The aesthetic development of the child through art, music, and literature might well be correlated with an artistic view of the environment.
3. The physical education of the child might include varied experiences with outdoor activities.
4. The children should be given opportunities to develop a social conscience and to formulate and apply ethics to interactions with peers and the community at large.

The psychomotor domain involves many motor-perceptual skills, including mastering the use of a variety of tools such as hammers and saws, making instruments, handling apparatus, making maps and plans, and making models.

Values Development

Values development among children is an integral part of science education and is based upon a gradual development of understanding rather than direct teaching.

For example, children who examine the needs of plants and animals also can become aware of their responsibilities to living organisms. Examination of the interactions between plants and animals can lead to a respect and responsibility for maintaining successful relationships.

Using the Environment

Many of the recommended activities in this program involve leaving the classroom and using experiences in the environment to develop science processes. Teachers should be aware of good conservation attitudes and impart them to children by example as well as by formal instruction. Collection of specimens is to be discouraged and is *only* acceptable when *all* the following criteria are met:

1. Specimens are extremely common in the environment;
2. Specimens can be readily replaced by natural means;
3. Specimens are of value for further study in the classroom.

Planning and a sense of purpose will make any excursion from the classroom a meaningful experience for children. Using the environment includes not only the ambitious ventures to distant places but also school ground investigations which can be just as valuable for children.

Environmental studies within urban areas provide opportunities for development of other important attitudes. An example of this is respect for private and public property. Much can be accomplished in this regard by class discussion *before* an excursion is undertaken.

> "Take nothing but pictures,
> Leave nothing but footprints".

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[5] DAVID K. KRAWTHWOHL et al, *Taxonomy of Educational Objectives II: Affective Domain* (New York: David McKay, Inc., 1964), 196 p.

Organizing an Elementary Science Program

Organizing an Elementary Science Program

General Goals and Objectives

Inquiry skills, positive attitudes, and science concepts can be developed through the use of a variety of approaches and materials. In order to help schools develop an organizational framework for their science program, this section of the guideline presents general goals, specific objectives, and organizing patterns.

This program advocates the following goals for students:

1. To enable them to develop attitutes of accuracy, curiosity, objectivity, impartiality, and suspended judgement relative to evidence. These attitudes are important in the development of inquiry skills.

The program will help students participate actively in experiments and ask questions about objects or events; express their own ideas and use evidence to support their conclusions; listen to the ideas of others and evaluate evidence presented by other children; and their ideas in response to new evidence.

2. To enable them to develop careful strategies of inquiry in order to help continue to examine their environment.

The program will help students use basic and integrated processes to develop and propose generalizations about their environment; and examine a description of hypothetical or actual problem-solving events and evaluate the appropriateness of the working hypotheses, the techniques used, the data collected, and the conclusions reached.

3. To enable them to gain experience in their environment and develop positive attitudes toward their environment, self, and others.

The program will help students describe and help maintain a healthy environment; experience success in science activities; and exhibit attitudes of appreciation of other viewpoints.

4. To enable them to develop an appreciation of the interdependence of science learnings with other subject areas.

The program will help students use in other subject areas those skills of observation, measurement and interpretation, and other competencies which are developed or supported in elementary science.

5. To enable them to develop, to their level of maturity, an understanding of science concepts.

The program will help students recall pertinent facts, terms, and concepts; examine a scientific concept and apply or relate this concept to a situation which is different from that in which the concept was originally learned; and examine a complex situation and identify and analyze the relationship of the parts within the whole situation.

6. To enable them to develop those manipulative skills which are necessary for the use of materials and apparatus used in developing inquiry.

The program will help students use self-constructed or standard laboratory equipment appropriately.

7. To enable them to develop a continuing interest in examining the ideas of science.

The program will help students display continuing interest in the ideas or skills of science, as evidenced by participating in science activities of outside organizations, attending science clubs, designing science projects, performing extra class experiements and making personal collections of materials.

8. To enable them to develop skills of social interaction.

The program will help students demonstrate the ability to work cooperatively with others.

Process Development

Processes are intellectual skills which are developed and used both in science and other areas of study. When children experiment with materials and examine ideas, both processes and concepts are being used. ***Observation*** and ***classification*** skills are important to the development of more complex processes, such as interpreting data, and are therefore classified as ***basic*** processes. Children should begin to develop basic processes from their early experiences. ***Experimenting*** and ***controlling variables*** are termed ***integrated*** processes and can usually be more effectively learned by children at the late concrete and formal operational stages. Each process, in turn, consists of a series of levels of difficulty or sub-processes. For example, the process of observation varies from the skill of describing an object in terms of a single physical property to identifying the object in terms of its many properties. A summary of the process development outlined in the thirty-two units of the basic core is given on pages 14 and 15. The basic processes are gradually developed from Kindergarten through Grade 6. The integrated processes are stressed at the higher grade levels as the children begin to develop formal reasoning. It should be noted that many of the main processes often include other activities that reflect various aspects of that process. For example:

observing includes identifying;
classifying includes comparing and ordering;
communicating includes describing and graphing;
controlling variables includes the preliminary stage of identifying variables;
experimenting begins in the primary grades with teacher-directed investigations.

The Basic Processes

Observation

The senses are used to describe objects and events. Statements of observations are constructed in qualitative and quantitative terms. Devices are chosen to extend the senses, and those observations are selected which are relevant to an experience. Examples of statements of observations at different levels of complexity are: "describes objects in terms of colour", "identifies characteristics of well-concealed plants and animals", and "observes and records changes in the development of plant embryos".

Classification

Similarities and differences are used to sort objects, ideas, or events into groups according to their properties. Classification systems can be developed on the basis of one or more properties, directly or indirectly observed. Classification systems are arbitrary and their usefulness depends upon the function they serve. For example, a series of animals could be classified as follows:

Vertebrates—lion, mouse, giraffe

Invertebrates—grasshopper, amœba, earthworm

1 syllable—mouse

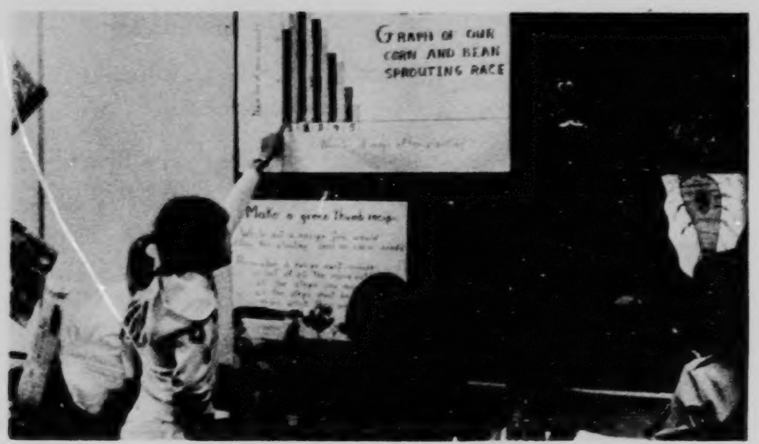
2 syllables—lion, giraffe, earthworm

3 syllables—grasshopper, amœba

Examples of classification at different levels of complexity are: "groups objects into two groups based on one property", "sorts rocks according to density and hardness", and "classifies groups of interacting objects and forces that are not directly observable by the unaided eye."

Communication

Appropriate means are used to describe an object, event, or relationship, and to transfer information. Models, maps, graphs, and other media can be used to represent data. Examples of communication include "communicating orally about interactions within systems" and "describing the conditions of an experiment in terms of what the experimenter does, the variables employed, and the measurement taken". Graphing simple data begins in grade one when children measure their bodies with strings or ribbon and transfer the lengths directly to a large sheet of paper (a one-to-one relationship). Graphing occurs with increasing complexity at subsequent grade levels. Skills of interpreting data from graphs are being developed by the end of Grade 6.


Graph of our corn and bean sprouting race
Make a green thumb recipe

Measuring

Observations are quantified initially using non-standard and then standard units. Length, area, volume, mass, time intervals, and force are among the measurements which are used. Appropriate measurement instruments and units within the metric system are selected. Examples of measurement include "using paper clips as standard units for measuring an object", "calibrating a scale", and "measuring the rate of hatching organisms".

Using Space/Time Relationships

All objects occupy points in space at a given point in time. This process concerns spatial relationships and the ability to describe such things as shape, symmetry, direction and spatial arrangement, motion and speed, and rate of change. Examples of using space-time relationships are "identify common shapes such as cubes, spheres and cylinders" and "measure the speed of moving objects".

Inferring

Inferring means suggesting more about a set of conditions than is observed. Inferences may evolve from both direct and indirect evidence and are modified on the basis of new evidence. Examples of inference include "inferring the identity of objects on the basis of observing their shadows" and "inferring why concealing colours may be a beneficial adaptation for animals".

Predicting

A forecast is made about future events on the basis of data. Predictions on the basis of ordered data, extrapolation beyond an observed pattern of events, and tests of predictions can be made. Examples of prediction include "predicting the appearances of adults that will grow from young animals" and "predicting the consequences of changes in an animal's habitat".

The Integrated Processes

The integrated processes are more complex and draw upon the basic processes. Many of the integrated processes overlap.

Defining Operationally

Objects and events are defined in a way which can be tested or observed. For example, an operational definition of a completed circuit would be, "When I join copper wires, a bulb, and a dry cell in this way, a bulb will light up".

Controlling Variables

Identification of a set of variables, isolation of the one variable from a set which affects the results of an event, and controlling those variables which may affect the result, are basic parts of this process. A child may test only one variable and disregard others. An example of failure to control variables often occurs in pet food preference tests. Many pets prefer warm over cold food. Thus, a conclusion "table scraps are preferred to pet food" might be reversed if both foods were served at the same temperature.

Formulating Hypotheses

Reasonable explanations are made. Observations that support or do not support hypotheses are made and the hypotheses are then accepted, rejected, or modified. Examples of hypotheses are "sound is closely related to vibration" and "increasing the weight of a pendulum bob does not affect the period of a pendulum".

Interpreting Data

Collected data is used to develop inferences or hypotheses. Thus, selecting data which supports inferences, identifying a general trend, and stating a conclusion or relationship are important parts of this process. Examples are "select the main trend from a graph of heartbeats taken after students have done exercise" and "state the average growth rate of bean plants".

Experimenting

This process involves all other processes. Experimenting usually begins with setting a problem to be solved. Steps involve stating a hypothesis, identifying the variables to be controlled, making operational definitions, devising a test, carrying out the procedure, collecting and interpreting data, verifying the hypothesis, and then sometimes revising and retesting the hypothesis.

Development of Conceptual Themes in Core

Conceptual themes, sometimes entitled the "big" ideas in science, can be used to provide direction for the development of a science program or unit. These broad ideas are developed from generalizations or concepts. Concepts, in turn, are developed from groupings of related information. Conceptual themes can help the school relate a number of topics and can help the child build useful major ideas rather than a series of unrelated facts and experiences.

Three main conceptual themes have been identified for the revised elementary science curriculum for Manitoba schools. They are:

Interdependency and Interaction among Organisms;
Changes in Matter and Energy;
Earth, Space, and Time.

This curriculum guide provides a series of core topics which will help schools develop their students' skills and understanding of concepts. Cooperative planning in the school is necessary to determine the approaches to be used, the nature of extension topics, and the organization of support materials. Some general principles which may be considered in planning the particular science program are as follows:

1. A balance among the life, earth, and physical science topics should be maintained;
2. Although topics have a degree of flexibility in terms of the level at which they can be placed, schools must maintain a sequence and avoid unnecessary repetition in terms of the concepts and activities to be developed;
3. Some topics, such as sound and changes in the environment, can readily be integrated with other areas of study;
4. Children's own interests can be used to lead them to examine new ideas and activities; however, interests alone cannot determine a science program.

Time Allotment for Elementary Science

Although the curriculum guide provides an outline of topics in terms of the concepts and skills to be developed at each grade level, no specific ordering of topics is proposed. Teachers may wish to organize the topics on the basis of seasons, the sharing of equipment within the school, or other reasons.

The concepts which are provided within a theme are related and become more complex as the student progresses from kindergarten to grade six. Similarly, the program emphasizes the simple processes and skills at the primary levels and the more complex processes and skills at the upper elementary levels. Since children are constantly defining and re-defining concepts and skills within their framework of experiences, teachers should be aware of their students' science experiences in the previous grade and the concepts and skills which will be developed during the succeeding grade level.

The program objectives are defined with the intent that as many children as possible can achieve success within the program. However, variations in age and abilities make it impossible for all children to achieve at the same rate or to the same level of understanding. Different groupings of children, according to the nature of the activity, is necessary. Groupings can include small working groups for activities using concrete materials and whole class groups for reviewing the results of activities and clarifying concepts which were developed.

It is recommended that, on an average, a minimum of fifteen minutes per day be allotted to the teaching of the science program at the K-3 levels. Teacher feedback indicates that, within this allotment, the core program would represent approximately 70%-80% of the total time. A minimum of thirty minutes per day is recommended for the science program in grades 4-6. The core program would then represent approximately 70%-80% of the time allotment. The curriculum guide provides additional extension objectives and topics which can be used to complete the remaining 20%-30% of the allotted time. Variations among students may require that different amounts of time be required in order to achieve the objectives.

Integration

Many teachers and schools may wish to integrate the science program with other subjects. When the skills or concepts being developed in different subjects are similar, the use of a theme which correlates the development of language, science, and mathematics skills can be very effective. The definition of the skills and concepts to be developed in the curriculum will enable teachers to maintain science as an identifiable part of the school program.

A Basic Core of Science Units

A series of thirty-two units, which comprises approximately 70%-80% of the elementary science program, has been developed to assist teachers to plan and organize the K-6 science program. The scope and sequence for the core units is presented on pages 39-61. This series of units represents the prescriptive component which is a major consideration in curriculum planning, sequencing, and in the purchasing of materials.

The remaining 20%-30% of the science teaching time can be spent according to the option of the teacher, e.g., pursuing some topics in more depth, conducting student projects, or going on field trips. The curriculum guide supports this intent by providing extension topics and/or extension objectives at all grade levels.

Selection and Use of Curriculum Materials

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Selection and Use of Curriculum Materials

When selecting materials for the program, the different emphases that each provides must be considered. Materials can vary in any of the following ways: the degree to which they place content into a sequential order; the emphasis placed on student activity; the degree to which student activities are structured; the methods of providing for differences among students; the extent to which metric units are used; and the teaching approaches emphasized.

Thus, a number of alternatives are available to a school in order to achieve the goals of a science program. Four sets of new elementary science curriculum materials have been recommended for use in Manitoba schools. Materials for the science program (core plus 20%–30%) can be selected from the following alternatives:

1. School can use a single textbook series which provides the organizational framework. Three textbook series which are recommended are Modular Activities Program in Science (MAPS), Elementary School Science (STEM), and Houghton Mifflin Science;

2. Schools can use selected student modules and teacher guides from a single series;

3. Schools can use materials from several series that provide units from an appropriate mix and match. This approach provides more alternatives for open-ended activities, a greater degree of integration, and less dependence upon a specific series.

The unit scope and sequence for the core topics is found on pages 39-61. Teachers from each school should cooperatively plan which materials they wish to select. Only three programs, STEM, MAPS, and Houghton Mifflin Science, provide sufficient units for a total K-6 program. Supplementary materials can be used to extend the program into other topics or subjects.

Recommended materials are compared in general terms on page 20. Annotations are provided in Appendix A in order to assist schools and teachers in selecting suitable materials for their science program. Recommended materials are also correlated with the topics in each grade level in the section "Information for Teachers" found at the beginning of the core topics for each grade level. Supplementary materials which do not support the core topics completely but may extend them are also correlated in the section, "Information for Teachers".

The Metric System: SI

Since the metric system (Systeme Internationale or SI) is being used in Manitoba schools, the following information is presented concerning the extent to which the metric system is applied within recommended materials:

Elementary School Science (STEM)
This program uses metric units only;

Modular Activities Program in Science (MAPS)
Imperial units are used in rare instances;

Houghton Mifflin Science
This program uses metric units only;

Science 5/13 (Teacher's Guides)
Quantities are expressed in metric units with Imperial units following in brackets;

Elementary Science Study (ESS)
This set of teacher's guides presents measurement both in Imperial and metric units.

The extent to which metric units are used in materials is one of the criteria that schools should use when choosing specific materials. It is suggested that students' materials should contain SI units. When curriculum materials are used as teacher's guides, teachers can convert Imperial units to SI.

The following supplementary materials have been suggested for use by teachers who may wish either to extend the science program into other topics and subjects or to modify the approach which is used to develop a topic:

BIOLOGICAL SCIENCES CURRICULUM STUDY, *The Elementary School Sciences Program* (ESSP) (New York: J. B. Lippincott Company, 1977). Canadian representative: J. B. Lippincott Company of Canada Ltd., Toronto;

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC., *Environmental Discovery Series:* (Teacher's Guide) (Washington, D.C.: National Wildlife Federation, 1971);

WENTHWORTH, DANIEL F. et al, *Examining Your Environment Series* (EYE) (Toronto: Holt, Rinehart and Winston of Canada, Limited, 1976);

BLECHA, MILO K. et al, *Exploring Science* (Toronto: Doubleday Canada Limited, 1977);

MALLISON, GEORGE G. SCIENCE*: Understanding Your Environment*, (Morristown: Silver Burdett, 1978). Canadian Representative: GLC Publishers Limited, Agincourt, Ontario;

KATAGIRI, GEORGE et al, SPIES: *Self-Paced Investigations for Elementary Science* (Morristown: Silver Burdett, 1976). Canadian Representative: GLC Publishers Limited, Agincourt, Ontario;

WOOLEY, IVAN (Editor), *Ryerson Science In Action Series* (Metric Edition) Toronto: McGraw-Hill Ryerson Limited, 1975).

MATERIALS COMPARISON CHART

	Elementary School Science (STEM)	**Modular Activities Program in Science (MAPS)**	**Houghton Mifflin Science**	**Science 5/13**
Approach	A sequenced activity-oriented conceptual approach. Deals with content topics such as light, populations, air, and air pressure. Some mathematics is built-in and can be integrated with other subject areas.	An activity-oriented process approach. Conceptual sequences are developed in units using processes, e.g., observing, describing. Mathematics is built-in. Can be integrated with other subject areas.	Similar to MAPS; however, additional information is provided in many of the topics.	An activity-oriented process approach. Follows Piaget's model in which progressively complex stages of child development are recognized. Incorporates graphing and idea testing. Integration with other subject areas is implicit
Materials	Teacher guidebook and well illustrated, hard covered texts. Pupil experience and record book is available. Most materials needed can be found in school and at home and easily stored to use again. Kit available but not essential.	Teacher guide books and well illustrated texts which are available either soft or hard covered. Publisher's kits available but not necessary. Materials are available in school or home. Audio-visual kits are available for each module.	Teachers guidebook and well illustrated, hard covered texts. Most equipment can be obtained from supermarkets and home.	A set of 26 teacher idea books. No student texts. A wide variety of reference materials must be available for student use. Simple, easily homemade equipment is used for the most part. Standard science equipment can also be used with great effectiveness.
Implications for Teacher	Structured program. Relies on basic texts. Does not require extensive science background for the teacher. Organization of student equipment is important.	Some preparation of materials is required. Familiarity with teacher's guide is a necessity. Does not require supplemental, teacher developed units or extensive science background.	Structured program which contains both development and some enrichment activities within lesson clusters. Familiarity with the teacher's guide is a necessity. Extensive science background is not required. Organization of equipment is needed.	Unstructured program with many excellent ideas. Requires teacher to organize materials and develop units with students directing much of work. Time is required to build and test homemade equipment. Program best for non-departmentalized class because of its integration of other subjects.
Implications for School	Easily implemented on single classroom or school basis. There is however, a cyclical approach in which topics are built upon throughout the K-6 program.	Individual modules can be used but the K-6 or K-3, 4-6 program should be considered for adoption.	The topics and processes are developed sequentially throughout the program. May be implemented on a single classroom or 1-6 basis.	Teacher guide can be acquired for a total program or as an idea reference set to enrich other programs. Record keeping required to ensure continuous skill development and prevent duplication.
Use of Local Environment	Indoor and outdoor activities with an environmental emphasis. Environmental issues are considered.	Some lessons require working in the local environment. Environmental issues are considered at higher levels.	Some lessons include outdoor activities. Environmental issues are considered at higher levels.	The activity-oriented nature of the program lends itself to use of the community both on and off the school grounds.
Flexibility of Content and Kinds of Activities	Available from K-6. Flexible for teaching groups or entire class. Units need not be taught in sequential order within a year.	Available from K-6. Three or four modules are available at each level and may be taught in any sequence. Scope and sequence chart shows distribution of concepts and processes. Some flexibility within the general structure.	Available from 1-6. Units may be taken in any sequence at a given level. Both small and large group activities are used.	Useful from K-8. Ideas from units can be followed directly or can be used to develop and enrich other textbook approaches. Activities can be modified for learning levels of students.
Student Evaluation	Evaluation suggestions are given with each lesson. Duplication masters for unit tests may be purchased for grades 3-6.	Duplicating masters of pre and post tests may be purchased for grades 1-6. Pupil progress chart is also available.	Evaluation suggestions are provided with each unit. A limited number of additional questions are provided in the teacher's guide.	No tests are available. Teachers are encouraged to evaluate through the use of objectives appropriate to child's developmental level.

Evaluation

Evaluation

The STEM, MAPS, and Houghton Mifflin Science programs have built-in evaluation techniques of tests. (See the following charts). Paper and pencil tests do not tell the complete picture of each child's progress. The evaluation report should indicate how well the related knowledge, skills, attitudes, and values have been learned by the children. This information will assist the teacher in gauging both the effectiveness of the teaching strategies as well as the overall success of the program.

To evaluate the program, the teaching, and the children's performance, one must have a clear statement of the basic goals and objectives, and then use the appropriate evaluation techniques. Evaluation of the child's learning should be based on the needs and abilities of each pupil. Many formal and informal evaluating techniques have been developed over the past few years which are suited to this purpose. Excellent guidelines for the construction of the more formal paper and pencil tests can be found in the more recent science methods texts such as the one by Anderson et al.[7] Some guidelines from Esler[8] for constructing tests items are included.

Rules for Constructing Multiple Choice Items

1. Design each item to measure an important learning outcome.
2. Present a single, clearly formulated problem in the *stem* of the item.
3. State the stem of the item in simple, clear language.
4. State the stem of the item in positive form wherever possible.
5. Underline negative wording wherever it is used in the stem of an item.
6. Make certain that the intended answer is correct or clearly best.
7. Make all alternatives grammatically consistent with the stem of the item and parallel in form.
8. Avoid verbal clues might enable students to select the correct answer or to eliminate an incorrect alternative.
9. Make the distracters plausible and attractive to the uniformed.
10. Vary the relative length of the correct answers to eliminate length as a clue.
11. Vary the position of the correct answers in random manner.
12. Make certain each item is independent of the other items in the test.

Rules for Constructing True-False Items

1. Include only one central, significant idea in each statement.
2. Word the statement so precisely that it can be judged unequivocally true or false.
3. Keep the statements short and use simple language.
4. Use negative statements sparingly and avoid double negatives.
5. Avoid giving extraneous clues to the answer.
6. Avoid the use of such words as *always, never, sometimes,* and *usually.*

Rules for Constructing Matching Items

1. Include only homogeneous material in each matching item.
2. Keep the lists of items short and put the brief responses on the right.
3. Use more or fewer responses than premises, and permit the responses to be used more than once.
4. Specify in the directions the basis for matching and indicate that each responses may be used once, more than once, or not at all.

Rules for Constructing Short-Answer Items

1. State the item so that only a single, brief answer is possible.
2. Use direct questions. Use incomplete statements only when the meaning is perfectly clear.
3. The words to be supplied should relate to the main point of the statement.
4. Place the blanks at the end of the statement.
5. Avoid giving extraneous clues to the answer.

Rules for Constructing Essay Test Items

Children should be encouraged to express their thoughts in writing as early as possible. Essay test items may be employed as soon as the children have learned to write sentences. A third-grade student's essay responses may be only one or two sentences long while a sixth-grader's may run to a paragraph. The teacher's expectations should match the child's writing ability.

1. Pose well-defined problems. Do not ask broad, general questions.
2. Be explicit. Indicate exactly what the child is to do.
3. Indicate about how long the answer should be.
4. Bear in mind the elements of the desired response. Know what comprises an acceptable response to a question.

Informal evaluation methods seem most appropriate for the objectives of the newer, more open-ended science programs. MAPS provides pupil progress charts for each unit. Checklists which note the presence or absence of particular behaviours are useful, although it should be noted that it is difficult to record the quality of behaviour by using a checklist only; anecdotal reports are more comprehensive. Several checklists measuring various types of behaviour are included here. Others may be found in two excellent reference sources.[9]

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[7] Ronald D. Anderson et al, *Developing Children's Thinking Through Science* (Englewood Cliffs: Prentice-Hall, Inc., 1970), p. 279-307.

[8] William K. Esler, *Teaching Elementary Science* (Belmont: Wadsworth Publishing Co. Inc., 1973), p. 85-86.

[9] Paul E. Blackwood and T. R. Porter, *How to Evaluate Science Learning in the Elementary School* (Washington: National Science Teachers' Association, 1968).

William K. Esler, *Teaching Elementary Science* (Belmont: Wadsworth Publishing Co. Inc., 1973).

Anecdotal records are useful to help measure the individual student's progress. Short comments can be recorded as the teacher moves from group to group as students perform investigations. Responses to questions can be recorded.

Files of selected work of individual students can be maintained for evaluation purposes. Progress through the year in inquiry skills, processes, and content knowledge can be gauged.

Skills of Inquiry

Names of children.	Is curious. Asks questions on variety of topics.	Predicts. Hypothesizes. Speculates.	Plans investigations. Observes closely. Keep records.	Repeats experiments. Gathers information from different sources.	Bases answers on evidence or on reliable data.

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Evaluating Performance with Manipulative Materials

	Names of children				
Manipulates materials with ease.					
Observes closely while working.					
Reveals stick-to-itiveness.					
Suggests new uses of materials.					
Finds relationships.					
Avoids hasty inferences.					
Describes discoveries clearly.					
Asks new questions.					
Is independent in clean up.					
Uses safety precautions.					

Checking the Growth of Inquiry Processes

	Names of children				
Suggested a prediction.					
Offered ways of testing prediction.					
Changed opinion for better idea.					
Selected materials with purpose.					
Used "I think", "I don't know".					
Criticized his/her own work.					
Observed carefully.					
Stated relationships while observing.					
Repeated work and/or changed for better procedures.					
Used data to draw inferences.					

Checking the Growth of Scientific Attitudes

	Names of children				
Shows willingness to have ideas questioned.					
Modifies views in the face of new evidence.					
Shows a disposition not to jump to conclusions.					
Looks upon guesses and hypotheses as ideas to be tested.					
Shows respect for ideas of others.					
Seeks data and information to validate observations or explanations.					
Exhibits a healthy skepticism for generalizations not based on verifiable (repeatable) observations.					
Questions conclusions based on incomplete data.					

Evaluating an Investigation

Teacher and Children Evaluate An Investigation (Group)

Problem:

1. What did we do that helped you most to find an answer to our questions?	
2. What could we have done better?	
3. What new ideas did we discover?	
4. What new words did we learn from this study?	
5. If you tried the experiments at home, were the results the same as in school?	
6. What predictions were we able to test with the materials we had?	
7. What different ways could we have used to keep records of our observations?	
8. What materials and equipment helped us most?	
9. What equipment did we have to construct?	
10. How did we use numbers and measurement to help find answers?	

A Description of Modular Units—in ESS and SC 5/13

Elementary Science Study

(Teacher's Guides). McGraw-Hill Book Company, New York. (Canadian Representative: McGraw-Hill Ryerson Limited, Scarborough).

Light and Shadows (Physical Science)
Children use various objects, light sources, mirrors and silhouettes to study the shape, size and clarity of shadows. Use in Core: ***Sun, Moon and Shadows*** (Grade 3).

Growing Seeds (Biological Science)
Students plant seeds, observe and record the plants' daily growth. An understanding of seed structure and of factors affecting growth of plants is gained. Use Core: ***Living and Non-living Objects*** (Grade 1).

Match and Measure (General Skills)
Through activities such as sewing, cooking, and carpentry, children learn to measure length, area, and volume. Measuring devices such as measuring sticks, tape measures, calipers, measuring wheels and geo-boards are used. Use in Core: ***Measuring Objects and Position*** (Grade 2).

Mobiles (Physical Science)
By making simple mobiles, children experiment with balancing systems. The students learn about the symmetry of shape and motion and the effect of weight on a balanced system. Use in Extension: ***Mobiles*** (Grade 1).

Life of Beans and Peas (Biological Sciences)
Students study the life cycle of a bean or pea from seed through to the second generation. The effects of various growing conditions are tested. Use in Core: ***Living and Non-living Objects*** (Grade 1).

Primary Balancing (General Skills)
In this unit, children learn about mass by sorting, comparing, and balancing a variety of objects. Use in Core: ***Properties of Material and Change*** (Grade 1).

Eggs and Tadpoles (Biological Science)
In this unit students examine the life cycle of the frog. Useful information is provided concerning the care of the animal during development. Use in Core: ***Living and Non-living Objects*** (Grade 1), ***Properties of Living Things*** (Grade 2).

Musical Instrument Recipe Book (General Skills)
This unit has illustrations and instructions for making more than 20 simple musical instruments of the string, wind and percussion varieties. Activities allow the students to learn how the physical properties of their instrument affect sound. Use in Core: ***Sound*** (Grade 4).

Attribute Games and Problems (General Skills)
Exercises with "A" block, colour cubes, people pieces and creature cards are used to develop the student's ability to classify objects. Classification problems are resolved on the basis of properties such as shape, colour, and other attributes. Use in Core: ***Properties of Materials and Change*** (Grade 1).

Animals in the Classroom (Biological Sciences)
This teacher's source book describes the necessary preparations for maintaining live animals in the classroom. Exercises with lizards, gerbils and pocket mice are provided. Use in Core: ***Plants and Animals*** (Level K), ***Living and Non-living Objects*** (Grade 1), ***Properties of Living Objects*** (Grade 2), ***Adaptations to the Environment*** (Grade 5).

Brine Shrimp (Biological Sciences)
In this unit students hatch brine shrimp and observe their life cycle. Factors which affect the hatching, growth, and survival rates of brine shrimp are examined. Use in Core: ***Populations*** (Grade 3), ***Changing and Preserving our Environment*** (Grade 6).

Changes (Biological Sciences)
Through activities the students observe changes in familiar substances. Light, temperature and other factors which affect spoilage of foods are compared. Use in Core: ***Properties of Materials and Change*** (Grade 1).

Mirror Cards (Physical Science)
Students duplicate and modify patterns through the use of mirrors and pattern cards. This unit supports the development of concepts in geometry and symmetry. Use in Extensions: ***Light*** (Grade 6).

Pond Water (Biological Science)
Skills in the use of the microscope and the collection of small pond life are developed. Comparison of different pond environments and the effect of different materials upon pond life are suggested. Use in Core: ***Properties of Living Objects*** (Grade 2), ***Changing and Preserving Our Environment*** (Grade 6).

Daytime Astronomy (Earth Science)
Activities with shadows are used to develop concepts of position and time. Sun clocks are made. Globes are used to make a sun - moon - earth system in order to enable students to examine relationships and to make predictions regarding seasonal change. Use in Core: ***The Earth in Space*** (Grade 5).

Sand (Earth Science)
Activities in this unit include sorting sand into different colours by sifting, making sand pendulums, sand jewellery, painting and

sculpturing with sand, making sand from small rock, and making sand timers. Use in Extensions: ***Properties of Material: Sand*** (Grade 2).

Structures (General Skills)
The students build specific structures out of materials such as plasticine, plastic straws and wood. Metal washers and other weights are used to test the strength of the structures. Use in Core: ***Structures and Forces*** (Grade 4).

Sink or Float (Physical Science)
The buoyance of different materials of the same shape and of different shapes of the same materials are tested in tap water, salt water and cooking oil. Factors affecting the rate of fall through cylinders containing liquid are examined. Use in Core: ***Water and Land*** (Grade 4).

Clay Boats (Physical Science)
Such factors as mass, volume, and shape are investigated in regard to their effects upon flotation. Use in Core: ***Water and the Land*** (Grade 4).

Drops, Streams and Containers (Physical Science)
Students conduct activities with common liquids (particularly water) to study flowing, dripping, and other properties of water. The effect of mixing different liquids is also examined. Use in Extensions: ***Properties of Liquids*** (Grade 3).

Mystery Powders (Physical Science)
The students observe and compare the properties of several common white powders such as starch, sugar, salt, baking powder and plaster of paris. Physical and chemical properties of the materials are used to determine the materials present in a mixture of powders. Use in Core: ***Change in Matter*** (Grade 3), ***Physical and Chemical Changes*** (Grade 5).

Ice Cubes (Physical Science)
Students examine the factors affecting the rate at which ice melts, e.g., insulation, temperature, surface area, and shape. The flotation of ice is also examined. Use in Core: ***Energy: Heat and Temperature*** (Grade 3).

Rocks and Charts (Earth Science)
The students classify rocks and minerals by comparing the characteristics of rocks. The classification includes the following criteria: slippery, rough, smooth, and layering. The results are recorded in charts. Use in Core: ***The Changing Earth*** (Grade 5).

Starting from Seeds (Biological Science)
The growth, greenness, and methods of reproduction of plants are examined. The emphasis of the unit is that of considering variables such as light, soil, water and temperature. Use in Core: ***Populations*** (Grade 3).

Where is the Moon? (Earth Science)
Students study the moon's changing position by using a measurement technique estimating the number of fists between the sun and the moon. Activities to predict the size, shape and position of the moon are suggested. Use in Core: ***Sun, Moon and Shadows*** (Grade 3).

Coloured Solutions (Physical Science)
The students use food colouring, water and salt to learn about density, mixing, and layering of liquids. Unknown liquids are tested. Use in Core: ***Changes in Matter*** (Grade 3).

Mosquitoes (Biological Science)
This is a resource book that describes the care of mosquitoes. The life cycle and factors affecting the behaviour of mosquitoes are studied. Use in Core: ***Adaptations to the Environment*** (Grade 5).

Whistles and Strings (Grade Skills)
The students use plastic tubing, straws and different types of string to investigate the physical conditions necessary to produce sounds and to change pitch and intensity of sounds. Simple musical instruments are made. Use in Core. ***Sound*** (Grade 4).

Bones (Biological Science)
This unit introduces students to the skeletal structure of animals. The assembly of skeletons, the study of photos and X-rays of skeletons and the making of skeletons from animals are described. The skeletons which may be assembled are disarticulated mink, cat and rabbit skeletons. Use in Core: ***Structure and Forces*** (Grade 4).

Small Things (Biological Science)
This unit introduces students to working with the microscope. Living and non-living things such as crystals, plant cells and protozoa are studied. The students learn to make their own slides. Differences between plant and animal cells, and cell growth are examined. Use in Extensions: ***Cells and Organ Systems*** (Grade 5).

Tracks (Biological Science)
The students study tracks in the classroom and outside, in snow and sand, and identify the animals and machines that made the tracks and their speed of movement. Track cards and a track picture book can be purchased separately. Use in Core: ***The Changing Earth*** (Grade 5).

Crayfish (Biological Science)
Activities include learning to handle, feed and house the crayfish; observing its behaviour in an environment; studying its external anatomy; and conducting feeding experiments. Use in Core: ***Adaptations to the Environment*** (Grade 5).

Activity Wheels: **A Teacher's Guide for Animal Activity (Biological Science)**
In this unit activities are provided to study the exercise rate of gerbils and the factors which affect that rate, e.g., the amount of light, noise, resistance of the wheel, temperature, and size of cage. Use in Core: ***Population Interaction*** (Grade 4).

Earthworms (Biological Science)
This unit examines the physical structure and behaviour of earthworms under various natural conditions. In addition, artificial environments are created in order to determine their effects upon the earthworm populations. Use in Core: ***Population*** (Grade 3), ***Population Interaction*** (Grade 4).

Peas and Particles (General Skills)
The students do activities with peas, beans, and other objects in order to develop an understanding of magnitude and the technique of estimating and sampling. Estimating and sampling techniques include counting the numbers in a sample or an area, by weighing and using ratio. Use in Core: ***Populations*** (Grade 3).

Batteries and Bulbs (Physical Science)
Students use cells, small bulbs, different kinds of wire, nails and compasses to carry out a variety of experiments on electrical circuits and electromagnetism. Use in Core: ***Electricity*** (Grade 4).

Optics (Physical Science)
Through the use of mirrors and light sources students conduct experiments in projection, reflection and refraction of light, and colour. Use in Extensions: ***Light*** (Grade 6).

Senior Balancing (Physical Science)
Concepts of force and equilibrium relative to a fulcrum are developed in activities involving balancing forces. Predicting the effect of forces, among other processes, is emphasized. Use in Core: ***Structure and Forces*** (Grade 4).

Behaviours of Mealworms (Biological Science)
The life cycle and behaviour of mealworms are examined. Children record, graph, and compare data obtained by studying such factors as how far a mealworm goes in 15 seconds, and whether a mealworm prefers to go up or down an incline. Use in Core: ***Population Interaction*** (Grade 4), ***Adaptation to the Environment*** (Grade 5).

Stream Tables (Earth Science)
A stream table is a system consisting of a waterproof box containing sand, water, dirt, gravel and a pump to circulate water. The simulation of streams and currents enables students to study soil erosion and other effects of currents. Use in Core: ***Water and the Land*** (Grade 4).

Water Flow (Physical Science)
Students use plastic tubing, connectors, water bottles and a peg board to build their own closed water-flow systems. The activities are designed to illustrate the behaviour of water within a closed system. Prediction of the behaviour of water under various circumstances is supported by the activities. Use in Core: ***Water and the Land*** (Grade 4).

Gases and "Airs" (Physical Science)
Students examine the nature of air and the changes it undergoes when it inter-reacts with common objects in the environment. The burning of a candle, the rusting of steel wool, and the germinating of seeds in a closed system are samples of activities which are suggested. Use in Core: ***Physical and Chemical Changes*** (Grade 5).

Batteries and Bulbs II
The students progress from the use of simple to complex electrical circuitry by making such devices as flashlights, electrical mazes, small motors and circuit boards. Use in Core: ***Electric Charges*** (Grade 6).

Kitchen Physics (Physical Science)
The physical properties of liquids are determined by experimenting with liquid flow through openings of different sizes, the formation of drops on different materials, the surface tension of liquids, and absorption of liquids by different materials. Instructions for making a soda straw balance are provided. Use in Core: ***Water and the Land*** (Grade 4), ***Forces and Motions*** (Grade 5).

Science 5/13

(Teacher's Guide) London, MacDonald Educational Ltd. The Science 5/13 program consists of units containing a wide variety of science activities which support the study of themes. In addition, activities which relate to other subject areas are presented. Piagetian stages are used to indicate the general levels to which specific units are applicable.

With Objectives in Mind (Guide to Science 5/13)
This unit examines child development in relation to the programs, philosophy of science education, the selection of objectives, and the design of the science units. The guide should be available to teachers who are using other titles from the series.

Early Experiences (Beginnings or Level I)
This unit emphasizes the skill of observation. Sample activities include the following: drawing and making shadows, comparing and sorting, using water, and growing things. Use in Core: ***Plants and Animals*** (K), ***Ourselves*** (Grade 1), ***Sun, Moon and Shadows*** (Grade 3), ***Electricity*** (Grade 4).

Early Explorations
This unit is designed to extend sensory perception and develop vocabulary through field studies. Activities include: describing outdoor experiences and the shapes of different bodies in the sky; using the senses outdoors; making collections of insects, leaves, and other objects; exploring numerical and spatial aspects of the environment; and discovering symmetry. Use in Core: ***Properties of Objects*** (K) and ***Sound*** (Grade 4).

Working with Wood (Stages 1 and 2)
The strengths, hardnesses, flotation properties, grain patterns, and other characteristics of different woods are tested and compared. The effect of the environment upon wood and man's use of wood are examined. Use in Core: ***Properties of Materials and Change*** (Grade 1), ***Changes in Matter*** (Grade 3), ***Sound*** (Grade 4).

Working with Wood (Background)
This unit provides teachers with information about such aspects of wood as its composition, its process of making food, properties of different woods, durability of timber, and how a tree is changed into lumber.

Coloured Things (Stages 1 and 2)
This unit suggests the use of coloured objects as a starting point for activities dealing with the properties of colour. For example, discussing the colour of a new carpet in the school library might lead to colour walks, paint mixing, fabric dyeing, and discussion on like and unlike colours. Changing colour by mixing colours, camouflage, the use of colour to beautify the urban environment, and colour and safety are examined. Use in Core: ***Ourselves*** (Grade 1), ***Population*** (Grade 3), ***Changes in Matter*** (Grade 3), ***Adaptation to the Environment*** (Grade 5), ***Changing and Preserving our Environment*** (Grade 6).

Change (Stages 1 and 2 and Background)
Changes in the environment, in position and motion, and various physical and chemical changes are investigated. A sampling of specific investigations includes weathering, mobiles, decay, and cooling things. Use in Core: ***Properties of Material and Change*** (Grade 1), ***Changes in Matter*** (Grade 3), ***Energy: Heat and Temperature*** (Grade 3), ***The Changing Earth*** (Grade 5).

Time (Stages 1 and 2 and Background)
Activities include the sequencing of events, making shadow and water clocks, investigating the action of pendulums, and reaction times. The students also study biological clocks, sky clocks, phases of the moon and other aspects of time. Use in Core: ***Time and Events*** (K), ***Comparing and Measuring Objects and Events*** (Grade 1), ***Measuring Time*** (Grade 2), ***Earth in Space*** (Grade 5).

Science from Toys (Stages 1 and 2 and Background)
A sampling of activities in this unit includes the use of toys to illustrate the forces of wind and inertia, the construction of toys, testing the buoyance of boats and toys, and investigating energy transfer in bouncing balls and other toys. Use in Core: ***Energy: Heat and Temperature*** (Grade 3), ***Electricity*** (Grade 4).

Structures and Forces (Stages 1 and 2)
The properties of the materials from which structures are made and the forces they can withstand are studied. A sample of activities includes the study of man-made structures and their design, the construction of geodesic domes, structures made with straws, the effect of forces on student-made bridges, and the differences among skeletons of various animals. Use in Core: ***Structures and Forces*** (Grade 4), ***Forces and Motion*** (Grade 5).

Ourselves (Stages 1 and 2)
The activities in this unit are designed to help the student become aware of his or her body and how its various parts function. Among the activities are: measuring height and weight, head shapes, head sizes, and fingerprints; and participating in various sensory activities. Use in Core: ***Ourselves*** (Grade 1), ***Measuring Objects and Position*** (Grade 2), ***Adaptations to the Environment*** (Grade 5).

Metals (Stages 1 and 2)
The activities in this unit are designed to help children explore the properties and uses of metals in their immediate environment. The

qualities of hardness, electricity and heat conductivity, resistance to corrosion and other characteristics of metals are investigated. Use in Core: ***Properties of Matter*** (Grade 2), ***Energy, Heat and Temperature*** (Grade 3), ***Electricity*** (Grade 4), ***Physical and Chemical Change*** (Grade 5), ***Electric Changes*** (Grade 6).

Metals (Stage 1 and 2)
The properties, sources, methods of extraction and uses of metal are described. Use in Core: ***Physical and Chemical Change*** (Grade 5).

Holes, Gaps and Cavities (Stages 1 and 2)
Numerous activities are presented in this unit to develop students' awareness of their surroundings. A sample of the activities includes the study of student-made parachutes with and without holes, shapes of holes and bubbles, shapes of drops of liquids made by straws and eye droppers, streams of liquids from squeeze bottles, sorting things by using filters and sieves. Use in Core: ***Changes in Matter*** (Grade 3), ***Water and the Land*** (Grade 4).

Minibeasts (Stages 1 and 2)
Through the use of insects such as worms, slugs, snails and spiders, students develop methods for studying animals. A sample of the activities include the location of animals around the school and during various seasons, collecting water animals, making use of collections, studying the length of the average worm, making graphs and studying life cycles. Use in Core: ***Properties of Living Objects*** (Grade 2), ***Population Interaction*** (Grade 4), ***Adaptations to the Environment*** (Grade 5).

Like and Unlike (Stages 1, 2 and 3)
This unit is designed to improve the student's ability to observe, sort, group and classify objects. Ivestigations include observing through the use of senses, sorting and classifying, measuring length, area, volume, and weight, determining texture and hardness, sequencing objects according to differences. Use in Core: ***Living and Non-living Objects*** (Grade 1), ***The Changing Earth*** (Grade 5), ***Light*** (Grade 6).

Children and Plastics (Stages 1 and 2)
This unit examines the properties and use of plastics. Activities include developing electric charges with plastics, studying its elasticity and strengths, permeability to water and uses. Use in Core: ***Electric Charges*** (Grade 6).

Using the Environment. The following units develop techniques through a variety of field studies:

2. Investigations: Part 1
A field trip is conducted within the local environment. Exercises involving counting, sorting, grouping and graphing are done after the field trip is over. In addition, exercises are provided to develop the concepts of mass, force, and density. The behaviour of small creatures is examined. Use in Core: ***Properties of Objects*** (K);

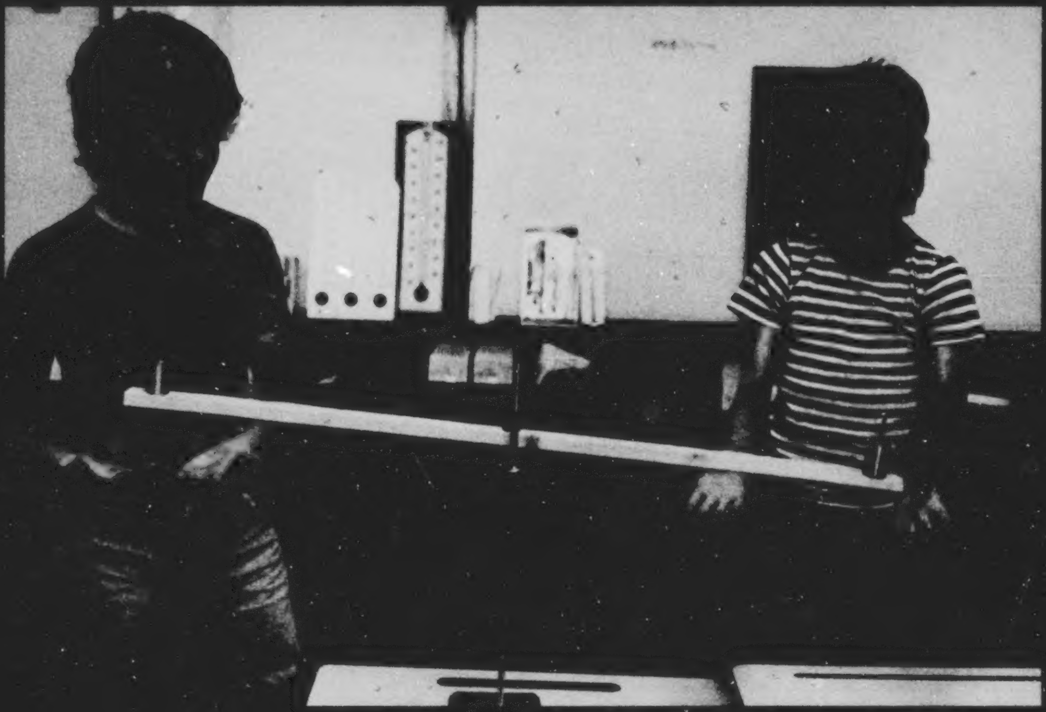
2. Investigations: Part 2
Rain is collected daily using a student rain gauge. Watering cans are used to simulate rain splashing from various heights. The simulation and effect of wind forces, changes in seeds, buds and tiny animals, and forces and machines are studied using children's toys and the playground. The recognition of distribution and the feeding habits of birds are investigated. Use in Core: ***Water and Land*** (Grade 4);

3. Tackling Problems: Part 1
Eggs, snails, nests, ponds, frogs, leaves and caterpillars are studied to illustrate the interdependence of living things. The relationship between plants, roots, stems and leaves is studied through activities and observation. The concepts of variation and adaptation are developed through investigations of seed dispersal and other activities. Use in Core: ***Population Interaction*** (Grade 4);

3. Tackling Problems: Part 2
Grids are made to study the distribution of living things. Techniques in sampling and using frequency charts and graphs are developed. Activities are suggested for the measurement of weather conditions such as rainfall, wind speed and direction; humidity, light intensity and temperature of soil, water and air. Pond and land slope studies are suggested. Use in Extension: ***Light*** (Grade 6);

4. Ways and Means
This unit provides information about conducting a field trip. Suggestions are given for the necessary facilities, equipment and raw materials for the trip. Among the activities are the making of a key to classify specimens, the integration of field trip findings with art, making homes for captured living creatures, the treatment of bones and skulls, and the use of garden plots.

Teacher References



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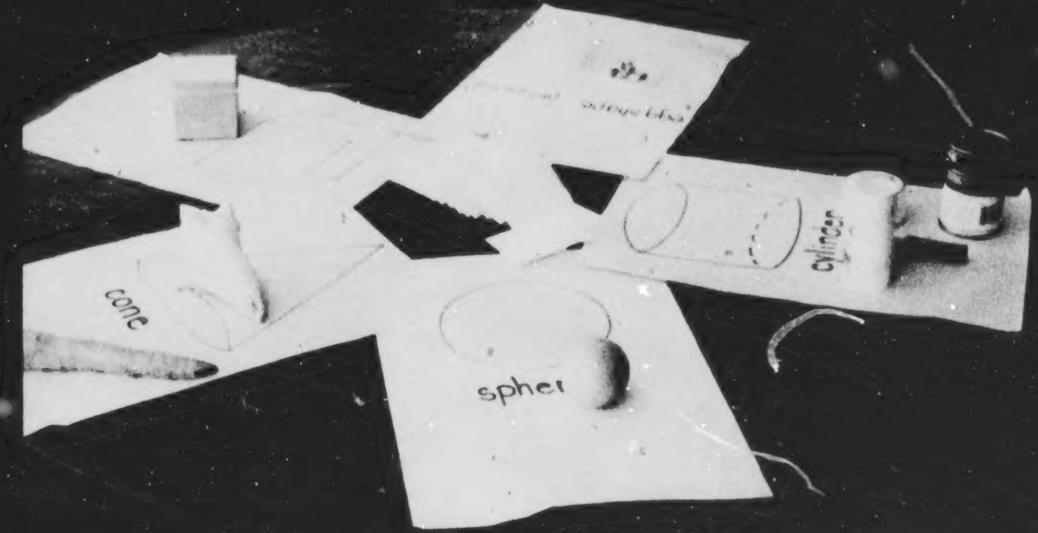
Scope and Sequence


cone
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Kindergarten

Theme **Interdependency and Interaction Among Organisms**

Concept **Plants and Animals are Living Organisms**

1. Animals are living, moving organisms which feed on plants and other animals. Different animals have different characteristics.
2. Plants are living organisms which require sunlight and water to grow.
3. Animals and plants require care.

Processes

Observing

1. Identify animals which require care by man.
2. Observe similarities and differences among animals.
3. Identify familiar animals.
4. Observe the embryo of a seed and describe what is inside a soaked bean.
5. Observe the growth of a bean.
6. Observe and compare bulbs of different plants and their growth.
7. Observe that different plants have different characteristics during their stages of development.
8. Observe that there are different plants and animals.

Classifying

1. Compare different characteristics of animals, i.e., colour, size, shape.
2. Classify animals according to similar characteristics, e.g., fish—birds.
3. Compare bulbs of different plants and their growth.

Measuring

1. Measure the growth of a bean using paper strips on a one-to-one relationship.

Communicating

1. Describe similarities and differences among animals.
2. Describe how some animals take care of their offspring and each other.
3. Describe what a plant needs to help it grow.
4. Describe the differences between wet and dry seeds.
5. Record pictorially the growth of a bean.
6. Graph the growth of a bulb (one-to-one relationship).

Inferring

1. Infer that man has a responsibility to care for animals other than pets, e.g., farm and zoo animals.

Values

1. Develop a regard for living things.

Kindergarten

Theme **Changes in Matter and Energy**

Concept **Properties of Objects**

1. All objects exhibit properties which can be used as a basis of identification and comparison.
2. The grouping or classification of objects is based on the similarities or differences of their properties.

Processes

Observing

1. Describe objects.
2. Observe properties of objects.
3. Identify and describe objects in terms of observations made with the sense of touch.
4. Identify objects in terms of the kind or volume of sounds that they make.
5. Identify objects on the basis of taste, smell, colour.
6. Observe that mass is a property which identifies objects.

Classifying

1. Compare sounds on the basis of loud and soft, high and low.
2. Classify objects on the basis of colour.
3. Observe and compare objects on the basis of two-dimensional shapes (circle, triangle, square, rectangle).
4. Observe and compare objects on the basis of size.
5. Classify objects on the basis of shape, shape and size, size and colour.
6. Observe and compare objects on the basis of texture, hardness.
7. Classify objects in terms of their weight.
8. Classify the same set of objects two or more ways in terms of colour, shape, texture and size.
9. Identify the characteristics by which objects are grouped, e.g., compare and order on the basis of size, length, width, mass.

Communicating

1. Graph the numbers of different coloured objects in the room.

Inferring

1. Infer the identity of an object on the basis of its properties.
2. Identify objects by using the senses of touch, hearing, taste, smell.
3. Infer the shape of objects on the basis of touch.

Theme **Earth, Space, and Time**

Concept I **Size and Position of Objects**

The position and size of an object can be described in specific terms.

Concept II **Time and Events**

Processes

Space/Time

1. Distinguish between long and short time intervals.
2. Compare the speed of objects and events.
3. Order events chronologically.

Measuring

1. Recognize the passage of a day by observing the completion of a cycle of a day.
2. Recognize the passage of a week, a month.

Communicating

1. Demonstrate and communicate the following relative positions, sizes, and motions: up/down, forward/back, left/right, short/tall, in/out, near/far, and above/below.

Grade 1

Theme **Interdependency and Interaction among Organisms**

Concept I **Living and Non-living Objects**

Objects can be classified as living and non-living according to certain properties

1. Objects have certain unique properties.
2. Living and non-living objects can be classified on the basis of the following characteristics:
   a) need for food and water;
   b) ability to grow, reproduce, die.

Processes

Observing

1. Observe live objects and discuss their characteristics and their needs, e.g., food and water, growth, reproduction, death.
2. Observe that plants produce seeds.

Formulating Hypotheses

1. Hypothesize about the form and shape of an adult plant when using cuttings from another plant.

Classifying

1. Classify objects according to size, shape and colour (review).
2. Compare living objects to non-living objects on the basis of growth, need for food and water, and reproduction.
3. Compare and classify seeds as large or small.
4. Compare plants with non-living objects.
5. Classify objects into living and non-living groups.

Communicating

1. Define living objects.
2. Define non-living objects.
3. Make a simple bar graph showing the growth of plants from different seeds. Compare their growth.

Concept II **Ourselves: There are variations and similarities among human beings**

1. Bodies vary in height, weight and shape.
2. Heads vary in size and shape.
3. Arms and legs vary in size and strength

Processes

Observing

1. Observe head shapes and differences in eye colour.
2. Observe differences in foot shapes.
3. Observe and compare differences in finger prints.

Communicating

1. Using a bar graph, compare differences in the height of children.

Classifying

1. Classify head shapes and eye colours.
2. Classify ear lobes according to variations in shape.
3. Classify types of hair (colour, straight, or curly).

Inferring

1. Infer relationships between hair colour and eye colour.

Measuring

1. Measure heights from a centimetre chart.
2. Measure and compare head sizes (using paper strips).
3. Measure and compare the length and width of feet (tracing on graph paper).
4. Measure and compare leg power (in terms of jumping height).
5. Measure and compare finger length (one-to-one relationship).
6. Measure volume of hand (displacement of water).
7. Measure arm strength.

Grade 1

Theme **Changes in Matter and Energy**

Concept **Properties of Materials and Change**

1. Change occurs when the properties of objects (matter) are modified.
2. Change occurs in observable patterns of order and time, and occurs constantly throughout the environment.

Processes

Observing

1. Observe and identify changes in properties (solids) such as shape, size and colour on the basis of evidence.
2. Observe and identify changes in the properties of solids in water.
3. Observe changes in properties of solids when objects are heated or cooled.
4. Observe changes in the weather and infer whether they are rapid or gradual.

Predicting

1. Predict changes which will occur when water is added to some solids.

Classifying

1. Identify the basis on which sets of objects are classified. Classify objects (solids) on the basis of two properties.
2. Compare a specific property (hardness, texture, relative weight) in pairs of objects (solids). Compare three objects (solids) to determine the degree of a specific property.

Inferring

1. Infer the reason for change by comparing changed objects (solids heated) to the originals.
2. Compare and order pictures which illustrate change.
3. Differentiate between changes, in terms of ease of reversal.

Communicating

1. Describe objects in terms of properties.
2. Classify and graph a group of objects on the basis of single properties.
3. Describe evidence of change in form and colour (solids).
4. Describe changes in properties of solids in water.

Theme **Earth, Space, and Time**

Concept **Comparing and Measuring Objects and Events**

1. Objects can be compared, described, ordered and measured on the basis of arbitrarily chosen reference points and non-standard units.
2. Events occur in a particular order or sequence and have varying durations of time.
3. Events may be regular or irregular in frequency.

Processes

Observing

1. Observe the duration of events.
2. Observe and compare changes in objects over time.
3. Observe events for regularity or irregularity of occurence.

Communicating

1. Record the amount of time spent at tasks.

Space/Time

1. Observe by describing the position of objects (above/below, front/back, up/down, far/near), that the position of an object is determined relative to an arbitrarily chosen reference point.
2. Estimate periods of time from pictures.

Predicting

1. Predict the comparative duration of events.

Measuring

1. Compare sizes as large or small.
2. Compare the sizes of objects using a variety of arbitrary standards.
3. Measure objects using arbitrary units.
4. Measure distance using arbitrary units.
5. Sequence events.
6. Compare different regular time sequences.

Grade 2

Theme **Interdependency and Interaction Among Organisms**

Concept **Properties of Living Objects**

1. Living organisms can be classified according to properties.
2. Living organisms respond to external stimuli.

Processes

Observing

1. Identify some properties of living organisms (review).
2. Identify properties which are unique to each of the following animal groups: mammals, birds, reptiles, fish, insects, amphibians.
3. Identify properties which distinguish deciduous trees, conifers, shrubs and small plants.
4. Identify leaf patterns on deciduous trees, conifers, shrubs, small plants.
5. Observe how living organisms respond to stimuli such as touch, sound, light.
6. Observe that the direction in which a plant grows is affected by external stimuli.
7. Identify the changes which take place in the environment in response to seasonal change.
8. Identify some of the differences between plants and animals.
9. Observe that plants live in many different habitats within an environment.
10. Identify the habitats where animals live.
11. Observe and describe the effects of different soils upon seed growth.

Classifying

1. Identify different habitats within an environment and relate the habitat to certain animals.
2. Classify animals according to the animal groups.
3. Classify examples of leaves collected according to leaf patterns.
4. Identify and classify the responses that plants and animals make to seasonal stimuli.

Communicating

1. Record data on individual animals in each of six identified groups.
2. Describe what happens to plants when deprived of water or light; when placed in cold temperatures.
3. Describe the life cycle of some familiar plants and animals.
4. Discuss those animals that at birth resemble the parents and those animals that do not resemble their parents until mature.

Predicting

1. Predict plant movement in response to stimuli.

Defining Operationally

1. Define operationally each of the six animal groups: mammals, birds, reptiles, fish, insects, amphibians.

Grade 2

Theme **Changes in Matter and Energy**

Concept **Properties of Matter (Solids, Liquids and Gases)**

1. Objects (matter) commonly exist in three distinct forms: solids, liquids and gases.
2. Each form has characteristic properties.

Processes

Observing

1. Identify various properties of objects.
2. Observe and record some properties of metals.
3. Observe some properties of different liquids.

Inferring

1. Identify objects which are made of different materials.
2. Identify sample liquids on the basis of evidence.
3. Infer that gases take up space.
4. Infer that gases can make objects move.

Classifying

1. Compare objects made of one material and those made of more than one.
2. Classify objects in terms of the kind of material (metal, wood, fabric).
3. Compare samples of the same material in terms of a single property (woods, fabrics).
4. Identify different forms of the same solid as containing the same material.
5. Classify some objects according to identified properties (metals and non-metals).
6. Compare liquids to solids.
7. Compare, test, and order different liquids on the basis of properties.

Communicating

1. Observe and describe properties of liquids.

Interpreting Data

1. Test liquids for viscosity, absorbency and the ability to dissolve sugar.

Defining Operationally

1. Operationally define solids, liquids, and gases on the basis of common properties.

Theme **Earth, Space, and Time**

Concept I **Measuring Objects and Position**

1. The size and position of an object can be measured by non-standard and standard units.
2. The metric system is a world-wide standard system.

Processes

Communicating

1. Describe the position of an object relative to a reference point.
2. Demonstrate the six principal directions in space relative to an object (front, back, above, below, right, left).

Concept II **Measuring Time**

Measuring

1. Distinguish between regular and irregular events.
2. Estimate and measure short time intervals.

Measuring

1. Measure a variety of objects, using a basic reference unit.
2. Select appropriate sized units with which to measure small and large objects. Make a standard objects.
3. Estimate using the metric system.
4. Use metres and centimetres appropriately to measure objects.
5. Measure the position of an object relative to a reference point.

Grade 3

Theme **Interdependency and Interaction among Organisms**

Concept **Populations**

Populations vary, grow, and develop in different environments.

Processes

Observing

1. Observe the growth of a population within a specific environment.
2. Observe a community and identify its various populations.
3. Observe that populations are affected by environmental stimuli.

Classifying

1. Classify population as plant or animal.
2. Match organisms to their habitats.
3. Identify the relationships between populations in a community.

Measuring

1. Measure the size of a population using sampling techniques.

Communicating

1. Graph the number of objects found in a specific area in a given amount of time.
2. Observe and record changes in organisms which have been raised as a classroom population.
3. Discuss possible causes for human population problems.
4. Discuss the effects organisms can have on a community or mankind as a whole.

Predicting

1. Predict how the removal of one population in a community affects the remaining populations.
2. Predict changes in classroom populations.

Inferring

1. Infer causes of population decrease.
2. Infer that colour is important for an animal's survival.
3. Infer that organisms can be labelled helpful or harmful depending upon one's viewpoint or values.

Defining Operationally

1. Operationally define a population.
2. Operationally define a habit.

Values

1. Discuss man's ability to endanger a population or to cause it to become extinct.

Grade 3

Theme Changes in Matter and Energy

Concept I **Energy, Heat and Temperature**

1. Heat is a form of energy.
2. Heat can produce changes in the properties of matter.

Processes

Observing

1. Identify the interaction between two objects.
2. Observe situations where energy does work.
3. Observe the effects of variables which will change the motion of an object.
4. Observe different kinds of energy and the interactions which have produced motion.
5. Identify heat as a form of energy.
6. Observe that differences in hot and cold can be detected by the skin.
7. Observe that solids expand when heat is applied and contract when heat is removed.
8. Observe that the melting rate of an ice cube can be altered by changing its form or by the use of insulators.

Classifying

1. Classify conductors according to their ability to carry heat.

Predicting

1. Predict the effect of heat upon objects.
2. Predict the effect materials will have on the melting rate of an ice cube.

Controlling Variables

1. Predict and investigate the variables that may affect a thermometer reading.
2. Investigate the variables that affect a thermometer.

Measuring

1. Measure water levels during evaporation and record the measurements on a graph.
2. Observe, measure, and compare expansion and contraction of liquids and gases.

Inferring

1. Infer that the skin is not a reliable instrument to measure hot and cold.
2. Compare the expansion of two solids and infer that solids expand different amounts.
3. Infer that heat causes expansion and loss of heat causes contraction in a gas.
4. Infer that heat causes expansion and removal of heat causes contraction in liquids.
5. Infer that different liquids expand different amounts.
6. Compare the insulating qualities of materials and infer that materials vary in their ability to conduct heat.

Communicating

1. Record temperature using calibrated thermometers.
2. Record data on a graph.

Grade 3

Theme **Changes in Matter and Energy**

Concept II **Changes in Matter**

Matter is made of particles which are too small to be seen.

Processes

Observing

1. Observe that two objects cannot occupy the same space at the same time.
2. Observe that a liquid takes the shape of the container into which it is placed.
3. Observe that solids will occupy space in liquids.
4. Observe the similarities between the properties of large and small parts of an object.
5. Observe that small particles can be used to form larger pieces of matter.
6. Identify solids that float or sink in water.
7. Observe and compare filtered mixtures of solids and liquids.
8. Identify solids which dissolve readily in water to form a solution and cannot be separated from the water by filtration; identify solids which do not dissolve readily and can be filtered out.
9. Observe from the fact that the physical properties of the solids are retained, that dissolving is a physical change.

Classifying

1. Classify solids according to their attraction by magnets.
2. Classify mixtures of water and solids as solutions or suspensions, and record changes over time.

Controlling Variables

1. Test the effect of different temperatures upon the rate of evaporation. Identify variables that affect the rate of evaporation.
2. Test the ability of various filters to prevent an odour from escaping.
3. Test different filters used to separate solid-liquid mixtures.

Predicting

1. Predict the effects of adding insoluble solids to liquids.
2. Predict the ability of magnets to attract solids.

Inferring

1. Identify and infer the presence of sugar in a solution of sugar and water.
2. Compare the properties of a solution before and after filteration.
3. Infer that solids, when dissolved, have the ability to pass through small openings in a paper towel.
4. Observe the formation of condensation and infer the presence of water vapour in the air.
5. Observe and infer the presence, by smell, of a substance which passes through a membrane.

Grade 3

Theme **Earth, Space, and Time**

Concept I **Air and Air Pressure**
Air is a form of matter which has special properties.

Processes

Observing
1. Observe the effects of air pressure counteracting other forces.
2. Observe that warm air rises and cold air sinks.

Inferring
1. Infer the presence of air by the resistance if offers.
2. Infer the presence of air by its displacement of water.

Concept II **Sun, Moon and Shadows**
1. The structure of an object affects the transmission of light through it.
2. The passage of time and the structure of an object can be determined from the shadows cast by it.

Processes

Observing
1. Observe the elements necessary to produce a shadow.
2. Observe that the size of the light souce affects the type of shadow produced.
3. Observe that the size, shape, and sharpness of a shadow change with the relative positions of the light, object, and screen.
4. Observe and compare two reflecting surfaces.
5. Observe the shadows caused by clouds and other objects in the environment.
6. Observe that the moon appears to move across the sky.

Classifying
1. Distinguish among opaque, transparent and translucent surfaces and observe the resulting shadow.

Inferring
1. Infer the shape of an object by looking at its shadow.
2. Infer the number of light sources by observing the number of shadows.
3. Infer the presence of light if an object is seen.
4. Infer the location of the sun by observing the shadows.

Communicating
1. Observe and record the phases of the moon.

Defining Operationally
1. Simulate the sun/earth relationship (interaction).

Predicting
1. Predict the direction a shadow will fall when a light source is placed in various positions.

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Grade 4

Theme **Interdependence and Interaction among Organisms**

Concept **Population Interaction**

Interaction occurs within and amongst populations.

Processes

Observing

1. Observe and describe interactions necessary for animals to build their homes.
2. Observe a food chain.
3. Observe how one kind of animal can cause environmental changes.

Inferring

1. Infer ways in which various animals care for their young.
2. Infer that some organisms are animal eaters (carnivores).
3. Infer the interactions of one kind of organism with its environment.
4. Infer how humans interact with other organisms.

Classifying

1. Classify young organisms as dependent or independent.
2. Classify organisms as plant eaters (herbivores).
3. Classify predator-prey relationships.
4. Classify plants and animals according to feeding behaviour, i.e., scavenger or decomposer, producer and consumer.
5. Identify organisms which make up a food chain.

Defining Operationally

1. Operationally define plant eaters (herbivores) and animal eaters (carnivores).
2. Operationally define predators and prey.

Communicating

1. Observe and record changes in decomposing matter and interpret the data.
2. Identify food webs by means of diagrams.

Values

1. Since some resources are limited, man must interact with his environment in a responsible manner.

Grade 4

Theme **Changes in Matter and Energy**

Concept I **Electricity**

1. Electricity is a form of energy.
2. Electrical energy can be changed to heat energy and light energy.

Processes

Observing

1. Observe how a switch affects an electrical circuit.
2. Observe the various ways in which several cells can be joined to one bulb.
3. Observe the number of bulbs which can be lit in a series circuit and in a parallel circuit.
4. Observe that the removal of one bulb from a series circuit causes all bulbs to go out, but the removal of one bulb in a parallel circuit does not.

Classifying

1. Classify materials as either conductors or non-conductors of electricity.
2. Classify metals according to their ability to conduct electricity.

Predicting

1. Predict and test the ways in which one cell can light a single bulb.
2. Predict and test which methods of connecting cells will provide the brightest light.
3. Predict and test the effect upon a circuit as the length of a wire is increased.

Communicating

1. Observe and diagram the structure of a light bulb.

Inferring

1. Infer that lengthening the wires in a circuit will increase resistance.
2. Infer that the filament in a flash-light bulb is part of the circuit.

Defining Operationally

1. Operationally define a light bulb and an electrical circuit.

Theme **Changes in Matter and Energy**

Concept II **Sound**

Energy transferred from one particle to another creates sound.

Process

Observing

1. Observe sounds made by vibrating objects and closed columns.
2. Observe that sound travels in all directions from a source.
3. Observe that a sound requires measurable time to travel between two points. Light appears to be instantaneous (new).
4. Observe and compare sound intensity through solids, liquids, and gases.
5. Observe sound wave conductivity of various materials.

Controlling Variables

1. Control variables which affect the pitch of sounds (column).
2. Control variables which affect the conduction of sound.

Measuring

1. Measure the lengths of a vibrating objects and relate the length to pitch.

Formulating Hypotheses

1. Formulate hypotheses about the nature of sound.

Experimenting

1. Experiment with factors affecting pitch and the conduction of sound.

Inferring

1. Infer the nature of an object using only the sense of hearing.
2. Infer the nature of an object or event from familiar sounds.
3. Infer direction from which sounds are produced.
4. Infer that we may eliminate sound when we concentrate on certain activities.
5. Infer that vibrating objects produce sound.
6. Infer that the grooves on a record cause vibrations which produce sound.
7. Infer that pitch is related to length of a closed column.

Values

1. Discuss responsibility for the control of man-made noise.

Grade 4

Concept III **Structures and Forces**

The design, size, and materials of a natural or man-made structure will determine the forces it can withstand.

Processes

Observing

1. Observe and compare structural differences among objects.
2. Observe that the balance point of a metre stick will change as masses (forces) are added to it.
3. Observe that the materials used in the structure of a tower affect its strength.
4. Observe the cross-section of a tree.
5. Observe animals with exoskeletons and endoskeletons.
6. Observe the bones of birds and compare them with the bones of land animals.

Controlling Variables

1. Observe and describe the variables in design which affect the strength of a structure.

Measuring

1. Measure the effect of additional layers on the strength of a structure.

Predicting

1. Predict the corresponding forces on either side of a balance beam.

Formulating Hypotheses

1. Formulate hypotheses about structural design and forces.

Communicating

1. Demonstrate how structure affect function in three fruits and vegetables.

Inferrring

1. Observe and infer the structures and functions of different types of skin.
2. Infer that root systems transport moisture to leaves.
3. Infer that the strength of an object is dependent upon its shape.
4. Infer the age of a tree by observing its growth rings.
5. Infer that the porosity of the bones of birds is an aid to flight.

Defining Operationally

1. Operationally define a pen and a pencil.

Theme Earth, Space, and Time

Concept **Water and Land**

1. Water is a liquid which erodes the land.
2. Water supports and transports materials.

Processes

Observing

1. Observe the effects of rainwater on the local environment.
2. Observe the erosive effects of flowing water and the formation of land features.
3. Observe that moving water holds more material than still water.
4. Observe the effects of evaporation and absorption on water levels.
5. Observe that there are spaces between soil particles which could hold water.
6. Observe the changes in water as it goes through its cycle.

Measuring

1. Measure the capacity of a boat using marbles as a standard unit.
2. Measure the relative proportion of air and water required to sink a hose.

Values

1. Relate information learned about water and land to human activities and problems.
2. Respect and understand the value of water to humanity and all other forms of life.

Predicting

1. Predict the shape of a clay boat which will support the greatest mass.
2. Predict which objects will sink and which will float (from a group of objects).
3. Predict the balance of air and water which will cause a hose to sink or float.
4. Predict the effects of movement in water upon rock particles.

Grade 5

Theme **Interdependency and Interaction Among Organisms**

Concept **Adaptations to the Environment**

Adaptations help organisms survive in their environments.

Processes

Observing

1. Observe adaptations of some organisms.
2. Identify specific adaptations of an organism.
3. Observe different types of feet in ani[illegible]d compare their functions.
4. Observe different types of body covering of animals and compare their functions.
5. Observe different types of roots in plants and compare their structure.
6. Observe different types of plant stems and compare their function.
7. Observe different types of movement in animals and compare their function.
8. Observe coniferous and deciduous trees and compare the benefits of each type of adaptation.
9. Observe adaptations that aid in the survival of a chicken egg.
10. Observe and relate patterns of behaviour in animals and relate these to survival in a changing environment.

Classifying

1. Observe and classify adaptations that aid in seed dispersal for plants.

Defining Operationally

1. Operationally define adaptation as any characteristic of an organism which provides it with an advantage for survival in a specific environment.

Inferring

1. Infer that adaptations may be structural or behavioral.
2. Infer advantages and disadvantages of different body coverings of animals and root types in plants.
3. Infer reasons for specific adaptations in plants and animals.
4. Infer the adaptations which allow for specific seasonal behavior.

Grade 5

Theme Changes in Matter and Energy

Concept I Forces and Motion

1. Objects in a system do not change their motion when forces are balanced.
2. Change of motion is the result of unbalanced forces in s system.

Processes

Observing

1. Observe forces acting on objects.
2. Observe forces causing an object to be put in motion and to change its motion (direction or speed).
3. Observe the force exerted by an object that is dropped.
4. Observe and record the directions of applied forces (arrows).
5. Observe the effect of a force on a series of objects.
6. Observe the strength of materials with reference to forces they can withstand.

Predicting

1. Predict the effect of forces upon objects.

Measuring

1. Measure weights with a student constructed spring scale.
2. Measure masses with a balance beam.

Inferring

1. Infer that varying the height of the drop will vary the force exerted by an object.
2. Infer that varying the mass of an object will vary the effect of the force exerted by a falling object.
3. Infer that the distance an object moves a spring in a spring scale is a method of measuring the weight of an object.
4. Infer that balanced forces act equally in opposite directions.

Communicating

1. Record the strength of materials with reference to forces they can withstand.
2. Graph force and distance relationships.

Controlling Variables

1. Identify variables (size, position and strength of student) that affect motion.

Formulating Hypotheses

1. Formulate hypotheses about balancing forces.

Defining Operationally

1. Operationally define force as a push or a pull.

Experimenting

1. Experiment with factors affecting forces and motion.

Concept II Physical and Chemical Changes

Changes in matter can be classified as physical or chemical.

Processes

Observing

1. Observe and compare the properties of different kinds of matter.
2. Observe that powdered or granulated solid will mix more rapidly with a liquid than a large piece of the same solid.
3. Observe materials that are undergoing irriversible chemical change.

Formulating Hypotheses

1. Formulate hypotheses about physical and chemical changes.

Classifying

1. Observe, measure and classify objects according to common properties.
2. Observe, measure and classify metals according to their hardness.
3. Classify materials as acid or base according to their effect upon litmus paper.

Inferring

1. Infer that matter has one or more properties which can be used in identification.
2. Infer, on the basis of evidence, that some changes are physical.
3. Observe the mixing of liquids and infer that heat and force affect the rate of mixing.
4. Infer that surface area (size of particles) affects the rate of dissolving.
5. Infer that the introduction of a gas can produce a reversible chemical change.
6. Infer that oxygen is consumed in the process of rusting.

Grade 5

Theme **Earth, Space, and Time**

Concept I **The Earth in Space**

People use the regular motions of the earth to measure the passage of time.

Processes

Observing

1. Observe the direction of the earth's rotation.
2. Observe through pictures, films, and other media, many of the objects found in near and distant space.
3. Observe and compare rotational motion to revolutionary motion.

Inferring

1. Infer that the rotation of the earth causes day and night.
2. Infer that the sun shines on the other side of the earth.
3. Infer that the motion of an object may be detected by comparing its position with the position of other objects.
4. Infer that a changing point of view may cause the illusion of motion.
5. Infer that the earth revolves around the sun.
6. Infer that the earth's axis is tilted.
7. Infer that the days of longest daylight are related to the position of the earth in its orbit when the axis leans towards the sun.

Defining Operationally

1. Operationally define one day.
2. Operationally define one year.

Concept II **The Changing Earth**

1. Sedimentary rocks are formed in a number of ways.
2. The structure of sedimentary rocks provides clues to how the earth has changed.

Processes

Observing

1. Observe the process of crystallization and discuss how it relates to mineral growth in nature.
2. Observe the role of cements in forming some sedimentary rocks.

Predicting

1. Predict the formation of crystal by evaporation.

Classifying

1. Classify rocks according to structure and properties (colour, hardness, layering, grain size).

Inferring

1. Infer the order of deposition from layered structures and infer the process of sedimentation for some layered rocks.
2. Infer the origin of some sedimentatary rocks as either sedimentation or precipitation.
3. Infer some of the conditions under which rocks might have been formed.

Measuring

1. Measure the speed of particles settling in water.

Communicating

1. Use graphs to describe the speed at which particles settle in water.

Formulating Hypotheses

1. Hypothesize the order in which rock particles will settle in water.

Defining Operationally

1. Simulate the formation of fossils and infer change on the basis of evidence.

Grade 6

Theme Interdependency and Interaction Among Organisms

Concept I **Interaction of Populations with the Environment**

1. Populations interact with each other and with their environment.
2. Structural and behavioral adaptations enable populations to survive in their environment.

Processes

Observing

1. Observe producers during growth.
2. Observe interactions of organisms and adaptations supporting survival of species.

Communicating

1. Describe the actions of one neighbourhood animal in defending its territory.
2. Observe and record on a graph, the number of plants sprouted in relation to the number of seeds planted.
3. Identify ways in which science has improved food production.

Formulating Hypotheses

1. Formulate hypotheses concerning factors affecting the success of a plant.

Classifying

1. Classify organisms as first, second, and third-order consumers.
2. Classify various kinds of seeds.

Inferring

1. Infer that abundant seed production increases the possibility of species survival.
2. Infer that plant populations compete for food, water, and sunlight, all of which influence their growth and success.
3. Infer that movement to a new territory is sometimes necessary for the survival of an animal.
4. Infer factors which affect population density.
5. Infer that natural or man-made factors can cause a population density in a given unit area to change.
6. Infer that people form generalizations and that people are slow to change these generalizations when presented with a situation that is contrary to past experiences.

Measuring

1. Measure the total weight gained by a person since birth.
2. Measure the average weight of food consumed in a 24-hour period for one student.
3. Measure the weight of the lifetime food intake for one student.

Interpreting Data

1. Interpret data and develop inferences about the reasons for variations in the populations of major cities in the world.
2. Interpret data and infer possible reasons for the success of a plant.

Values

1. Discuss the implications of an increased population on the environment and on the individual.

Theme **Interdependency and Interaction Among Organisms**

Concept II **Changing and Preserving our Environment**

1. A constant succession of changes occurs within the environment.
2. Changes are dependent upon the interaction of populations, the recycling of materials, and the quality of the environment.
3. Man has a major influence on the environment.

Processes

Observing

1. Observe some changes in living organisms.
2. Observe the water cycle in a closed terrarium.
3. Observe population changes in an ecosystem.

Communicating

1. Observe and record changes over time in a small ecosystem and make inferences from the data.

Controlling Variables

1. Control variables in an artificial environment.

Defining Operationally

1. Operationally define the water cycle.
2. Operationally define an ecosystem as several different populations interacting with each other and their environment.

Classifying

1. Classify man's inventions according to the natural resources consumed and the waste materials produced by them.

Predicting

1. Predict the change in a population of an organism by changing environmental conditions.

Interpreting Data

1. Interpret data and infer that detergent has a negative effect on a population of algae.
2. Interpret data and develop inferences about the causes for differences in the amount of dust particles found in different areas.

Experimenting

1. Design an experiment to test the effect of detergent on algae.
2. Design an experiment to investigate the quantity of dust particles in certain areas.

Measuring

1. Measure the change in mass of a plant as it grows.
2. Observe and measure population growth in brine shrimp.

Inferring

1. Infer that species have changed over long periods of time.
2. Infer that plants and animals have adaptations that enable them to survive changes in their environment.
3. Infer that man has influenced the survival of some living things.
4. Infer the effects of man's actions on an ecosystem.

Formulating Hypotheses

1. Formulate hypotheses concerning the effect of chemicals on populations of brine shrimp.

Values

1. Be aware that recycling is one method of reducing the depletion of natural resources.

Grade 6

Theme **Changes in Matter and Energy**

Concept I **Forces and Machines**

The amount of energy derived from a machine is approximately equal to the amount put into it.

Processes

Observing

1. Observe that an object with a small surface area will fall more quickly than a similar object with a large surface area.
2. Observe the effect of forces acting upon various machines: the lever and inclined plane.
3. Observe that a wedge changes the direction of a force.
4. Observe wheels and axles.
5. Observe that the force needed to lift an object with a single fixed pulley is equal to the mass of the object and that the direction of the force is changed.

Predicting

1. Predict the forces that will balance a lever with an off-centre fulcrum.
2. Predict the height of an inclined plane required to move an index card a specific distance along a desk.

Interpreting Date

1. Record and interpret data relating the forces exerted by a marble on an index card to the release point and angles of an inclined plane.

Experimenting

1. Design an experiment to relate the forces and release point and angles of an inclined plane.

Communicating

1. Observe and record the effect of the location of the fulcrum of a lever on the distance each end of the lever moves.
2. Graph relation of surface areas to rate of fall of objects.

Inferring

1. Infer that many small forces may act together to form one large force.
2. Infer that a force exerted over a small area exerts a greater pressure than an equivalent force over a large area.
3. Infer that the relationship between balanced input and load forces on a lever is dependent on their location relative to the fulcrum.
4. Infer that an inclined plane decreases the force required to lift an object.
5. Observe and infer that less force than the weight of an object is needed to lift an object using a moveable pulley.

Formulating Hypotheses

1. Formulate hypotheses concerning the relationship between the forces a marble exerts on an index card and the release points and angles of an inclined plane.

Measuring

1. Measure masses by using a balance system.

Controlling Variables

1. Identify and control variables that affect the forces needed to move an object up an inclined plane.
2. Observe and compare the forces a marble exerts on an index card by controlling the release points and angles of an inclined plane.

Defining Operationally

1. Operationally define a wedge.
2. Operationally define a simple machine.

Grade 6

Theme Changes in Matter and Energy

Concept II **Electric Charges**

Electrical energy can be converted into or produced from other forms of energy.

Processes

Observing

1. Observe that a material may become electrically charged if it is rubbed against a different material.
2. Observe the attraction of an uncharged object by a charged object.
3. Observe the attraction and the repulsion of two electrically charged objects.
4. Observe the effects on an electrical charge of joining two insulated objects of different charge by a wire.
5. Observe that two different metals can produce an electrical current when they are placed into an acid or salt solution.

Inferring

1. Infer that there are two different kinds of electrical charges.
2. Infer that an electrical charge can be carried from one object to another.
3. Infer the presence of electrical currents by testing with a magnet.

Interpreting Data

1. Interpret data relating electro-magnetic strength to the number of coils of wire.

Controlling Variables

1. Control the variables affecting the strength of an electromagnet.

Formulating Hypotheses

1. Formulate a hypothesis relating static electrical charge to the amount of rubbing between two materials.
2. Formulate a hypothesis relating electro-magnetic strength to the number of coils of wire.

Experimenting

1. Design an experiment relating electro-magnetic strength to the number of coils of wire.

Theme Earth, Space, and Time

Concept Weather

Weather, an indicator of the conditions within the earth's atmosphere, is the result of interactions between matter and energy.

Processes

Observing

1. Observe that warmed fluids tend to rise and cooled fluids tend to sink.
2. Observe wind direction and speed, and the effect of various obstacles upon wind.
3. Observe that evaporating water cools an object.
4. Observe differences between temperatures within systems where condensation occurs and where no condensation occurs.
5. Observe cloud and fog formation in a model system.

Inferring

1. Infer direction of air currents.
2. Infer that a volume of air will hold a limited amount of water vapour.
3. Infer relationships between temperature, air capacity, and cloud formation.

Communicating

1. Record and compare the effects of factors such as the position of a thermometer, and the colour of soil on air temperature.
2. Record relative humidity, daily precipitation and the speed and direction of wind.
3. Describe the effect of wind direction upon local weather.
4. Demonstrate cloud and fog formation in a model system.

Defining Operationally

1. Operationally define convection, current, dewpoint, wind direction and speed, and humidity.

Measuring

1. Measure speed and direction of wind, precipitation, and humidity using student-made apparatus. Calibrate the apparatus.
2. Measure dewpoint in the classroom.

Formulating Hypotheses

1. Formulate hypotheses concerning the increase in forces in a sealed jar in which water has been placed; a relationship between temperature and humidity.

Kindergarten

The kindergarten program is based on three themes taught in four units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
Unit 1 Plants and Animals
Theme 2 **Matter and Energy**
Unit 1 Properties of Objects
Theme 3 **Earth, Space, and Time**
Unit 1 Size and Position of Objects
Unit 2 Time and Events

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested

A sequenced statement of core concepts and processes is to be found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled *Process Development* which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Kindergarten

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Plants and Animals	K	K	1	Early Experiences	Animals in the Classroom
Properties of Objects	K	K	1	Early Explorations Investigations Part 1	
Size and Position of Objects	K	K			
Time and Events	K	K		Time	

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	EXPLORING SCIENCE	SCIENCE: UNDER-STANDING YOUR ENVIRONMENT
Plants and Animals	Plants in the Classroom		R/K	1	1
Properties of Objects	Colour and Change Nature Hunt	Your Senses (T.R.)	R/K	1	1
Size and Position of Objects				1	
Time and Events				1	

Kindergarten

Interdependency and Interaction among Organisms: Plants and Animals

Main Concept: Plants and animals are living organisms.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. Animals are living organisms which move and which feed on plants and other animals.	**Students should be able to:** (a) Describe animals they know.	Have a general discussion about animals and students' perceptions of them.
	(b) Recognize and identify animals familiar to them from pictures.	Use pictures for comparison and discussion. The classification criteria are determined by the students.
2. Different animals have different characteristics.	(a) Observe animals and describe their similarities and differences, i.e., they move, they feed on plants and other animals.	Bring two or three live animals into the room. Observe. Note: Be aware of allergies.
	(b) Describe and compare the different characteristics animals have, i.e., they have different colour, size, shape, body coverings.	Discuss the differences and similarities in how they feel to the touch, how they move, and how and what they eat. Compare animals to people. Observe animals in a zoo or farm and discuss their characteristics. Pictures may be used for discussions if animals are unavailable, but the movement/sensory discussion will be more difficult. Art: Make murals of zoo animals Music: Animal songs Make an experience chart about a zoo or farm visit or about animals with which students are familiar.
	(c) Classify animals according to similar characteristics.	Give out pictures to the class and see how they group them e.g., birds, fish, zoo/farm animals, large or small. Have them give reasons for their classification. *Extension:* Discuss and give reasons for classifying the animals or for not accepting an animal into a group.
3. Animals require care.	(a) Describe how man cares for animals.	Discuss with students what they think caring for an animal involves. List the types of pets the students have.
	(b) Identify animals which require care by man.	Let them give examples of animals they care for and the activities they do to look after their animal. Attempt to draw from the students overall titles for these animals: pets, zoo animals, farm animals. Graph the numbers in each group. Visit the Humane Society.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Language Arts: Read *The New Pet* by Marjorie Flack; *Dogs, Dogs, Dogs* by Thomas Allen; *Cats, Cats, Cats* by Thomas Allen; *The Angus Books* by Marjorie Flack; *The Harry Books* by Gene Zion; *Hi Cats* by Ezra Keats. Language Arts: Make a book on classroom pets for the library corner. The students can draw a picture and dictate a sentence about their pets or the pets they would like to have.
	(c) Discuss the fact that man has a responsibility to care for animals other than pets.	Keep an animal in the room and discuss its needs. Give each student an opportunity to care for the animal (Note: Be aware of allergies). If unable to keep a classroom pet, arrange "visiting days" for those students whose pets may come to school.
	(d) Describe how animals provide care for each other, e.g., grooming monkeys, musk-ox, wolf pack.	Ask children if they can think of a time when animals take care of each other. If they do not think of examples, pictures of animals cooperating may help discussion.
	(e) Describe how some animals take care of their offspring.	Discuss how offspring are cared for. Invite a parent who has a baby and would be willing to come to discuss how the baby is cared for. If a child's pet has offspring and they can be brought to school, the children can share two levels of care: human for animal and animal for its young. Raise gerbils or guppies in the room. Film: Baby Animals.
	(f) Match pictures of animal parents and offspring and describe similarities and differences between parent and offspring.	Use pictures of animal parents and offspring for a matching activity. Art: Use modelling clay to make animal mothers and babies.
	Extension (g) Identify some animal parents who do not care for their offspring. (h) Discuss why these offspring may not be cared for, e.g., frogs, snakes, moth, butterfly.	Discuss reptile and insect species.
4. Plants are living organisms which require water and, in most cases, sunlight in order to grow.	(a) Describe what a plant needs to help it grow, i.e., sunlight, water.	Discuss with students what they think they need in order to grow plants. Record ideas for future evaluation. *Seeds and More Seeds* by M. Vicent Selsam
	(b) Describe the differences between wet and dry seeds.	Soak about fifty lima, yellow, or white beans overnight. Set aside an additional dry bean for each student. Prepare a paper cup with soil for each student.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Put one dry and one wet seed on a paper towel. Observe the differences with a hand magnifying glass. Plant both seeds in cups. Set the cups in sunlight and water them as required. Observe growth. *Why the Dandelion Has Fly Away Seeds* by Roslyn Cole.
	(c) Observe the embryo in a seed and describe what is found inside the soaked bean.	Soak lima beans.
		Open the beans and discuss findings (use magnifying glass). Place wet paper towels in a glass jar and place lima beans between the glass and towel. Language Arts: Listen to the record "Johnny Appleseed". Art: Use seeds to make pictures of animals or flowers.
	(d) Observe and record the growth of a bean.	Observe and discuss growth as it occurs. Record the growth pictorially.
5. Plants require care.	(a) Observe and compare bulbs of two different plants.	Examine four tulip or narcissus bulbs and enough onion bulbs for each student. Discuss, observe, and compare their characteristics. Decide which end to plant downwards. Bulb: A true bulb is composed of flesh, or scales that overlap each other like the layers of an onion.
	(b) Observe the growth of plants from a bulb.	Plant onion bulbs in soil in a paper cup and plant narcissus bulbs in pebbles and water. Put in a dark place for two weeks. Have pupils observe and draw pictures of bulb growth as changes occur.
	(c) Make simple graph records of growth (one-to-one relationship).	Cut strips of paper to record growth of the plant. Glue strips on construction paper each day.
	(d) Observe that different plants have different characteristics during their stages of development.	Encourage students to bring seeds or vegetables from home. Discuss where they can find seeds or what types of vegetables they may want to try growing: potatoes, carrots, melon, squash, tomato. Nutrition: Make a vegetable soup with the students. Have a vegetable week in which students prepare raw vegetables for the class to sample. Do the same with fruits. Save all the seeds. Keep milk cartons, marking pens, earth, and seeds or other objects they wish to plant, in an area where they can use the material and carry out experiments with little direction from you. Label all the material so that they can copy the name of the seed or plant they have potted.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(e) Develop a regard for living organisms. (Value development).	The care of these plants is the students' responsibility. Discuss any deaths or lack of growth of the plants in relation to care. Record the class projects and the experiments being done.
6. Plants and animals are living organisms.	(a) Observe that there are many different plants and animals.	Discuss the plants and animals that have been observed by the class in this unit. List any similarities the students feel that plants and animals have. List some of the differences. Take a walk in the community and observe the plants and animals that are seen. Discuss similarities and differences.

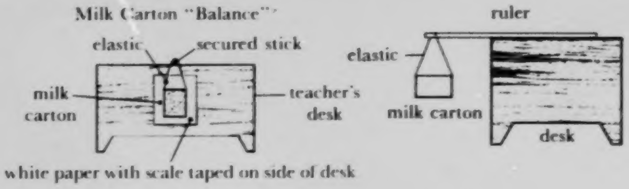
Matter and Energy: Properties of Objects

Main Concepts: All objects exhibit properties which can be used as a basis of identification and comparison. The grouping or classification of objects is based on the similarities or differences of their properties.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Objects exhibit a number of properties.	(a) Describe objects in their own words.	Provide a variety of objects including a paper clip, rubber band, crayons of different colours, metal and plastic spoons or similar materials. Have students describe the objects according to such properties as hardness, colour, ability to bend, and sounds made when the objects are tapped on the desk. Art: Make collages.
	(b) Observe the properties of objects.	Extend this kind of activity to objects in the classroom and objects out-of-doors. Observe the shapes of plants and leaves found in selected sites on the school grounds. Dig up a few plants (chickweed, dandelion) and compare their roots with those of a carrot or turnip. Use the top quarter of tap roots (dandelion) and plant them in soil with other weeds. Trim back the foliage. Care for the plants, observe changes, and discuss needs. Provide a table on which you display the objects students bring. Discuss the displays daily.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. Similar objects have similar properties.	(a) Infer the identity of an object on the basis of given properties.	One student describes one object out of a group which includes a paper clip, a rubber band, and wool thread. The other students attempt to guess which object it is. Play "I Spy" games in the classroom or school yard. Make a "feely" box or small individual "touch and feel" bags so that students describe an object without seeing it and try to guess what it is.
3. Properties of objects can be determined through a variety of senses.	(a) Identify objects using the senses of touch, hearing, taste, and smell. (b) Identify and describe objects in terms of observations made with the sense of touch.	Use collections of pine cones, bark samples, rocks (rough, smooth), and seeds and pods to help students explore the concept of texture. Enclose objects with different textures in a mystery bag and show a similar set to the students. One student touches objects in the bag and describes them. The other students identify the objects which are being described by comparing them to the exposed objects. *First Delights: A Book About The Five Senses*, by Tasha Tudor Language Arts: *Let's Do Fingerplays* by Grayson.
	(c) Identify objects in terms of the kind or volume of sounds that they make. Compare sounds and distinguish among them on the basis of loud and soft, high and low.	Drop a book from different heights. Fill a paper bag with air and burst it. Crumple paper. Blow bubbles through water and use various soundmakers to produce sounds. Students describe the sounds and identify the objects. Vary the loudness of a radio or record player. Students identify the location and describe the relative loudness and softness. Have students respond with body movement to high and low sound by loud and soft clapping or walking. Record loud and soft sounds from among the group listed above. Students try to identify "mystery sounds", to identify the effect of distance on sound, and to compare their abilities to hear the different sounds. Language Arts: Tape record sounds and make up a chart story.
	(d) Identify objects on the basis of taste (sweet, sour, salty).	Use lemons, a sugar cube, chocolate, and salt to identify specific tastes. Instruct students to use only a small portion. Provide drinks of water to remove taste of food. Note: Check on allergies of students. Use foods with similar tastes such as salted peanuts, salted crackers, pinch of salt; sugar, honey, syrup; and, pickles, lemons. Note: Students should be cautioned that taste should not be used as a general test.
	(e) Identify objects on the basis of smell.	Make mystery bags which contain pieces of banana, onion, cheese, orange, and objects soaked with an extract of peppermint or cologne. Give the bags to students. Instruct them to sniff carefully or waft the smell to their nose by using the

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		cupped hand. Have them identify the objects in the bags. Organize an activity corner with scented cards or vials containing paper towelling with cologne, extracts of peppermint, orange, and banana. Note: Students should be cautioned that smell should not be used as a general test.
4. Colour is a property of matter that identifies objects. Colours may be mixed to produce other colours (primary and secondary colours).	(a) identify objects on the basis of colour. (b) Observe and describe the colour of an object.	Use paper and crayons, food colouring, and pictures to introduce colour as a property. Have students use colour in identifying familiar objects such as traffic signs. Students can mix water and different food colourings or can draw with different coloured crayons. Fill plastic vials with liquids in primary colours (e.g., red and yellow) and have students experiment using an eyedropper to find out how many drops of each colour are needed to make the shade they like. Colour the water in your water table using food colouring in primary colours. Do finger painting using primary colours. Language Arts: Write poetry on the subject of colours. Have a week for each colour. Encourage students to wear or bring something with that colour. Have students make a book for each colour using a sentence model, e.g., Red is ______.
	(c) Graph the various coloured objects in the room.	Make a bar graph of the number of different coloured objects in the classroom, e.g., four yellow lights, six green chalkboards.
	(d) Classify objects on the basis of colour.	Group similarly coloured squares of construction paper, crayons, or other objects. Discuss objects which have the same colour and see who can identify that specific property (attribute blocks).
5. Shape is a property of matter that identifies objects.	(a) Observe and compare objects on the basis of two-dimensional shapes (circle, triangle, square, rectangle). Infer the shape of objects on the basis of touch.	Have students examine a variety of objects and group those of similar shape. Cut a circle, square, or other shape into parts and have children reassemble them. Fill a mystery box with stiff cardboard shapes and have students touch them in order to determine the shape. Use attribute blocks or objects in the classroom describing shape and colour. *Shapes*, by Mariam Schlein. Art: Use circle, triangle and square shapes cut from construction paper to make pictures.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
6. Size is a property of matter that identifies objects.	(a) Observe and compare objects on the basis of size.	Introduce the terms *larger than, smaller than,* and *the same,* by drawing identical shapes of various sizes on the board, or provide sets of similar shaped objects in pairs for comparison, e.g., tiles.
	(b) Classify objects on the basis of shape and size, and size and colour.	Use blocks or construction paper sets in two sizes and shapes to group objects. Use paper clips (three sizes and two colours).
7. Texture is a property of matter that identifies objects.	(a) Observe and compare objects on the basis of texture.	Display a variety of materials. There should be pairs in the display so that students can compare the objects by feel, e.g., smooth paper/rough paper (sandpaper); wool/satin; smooth willow twigs/rough twigs. Have students make texture books using materials such as velvet, corduroy, satin, hopsacking, tin foil, plastic wrap, sand.
8. Hardness is a property of matter that identifies objects.	(a) Observe and compare objects on the basis of hardness.	Provide an assortment of objects such as coins, washers, crayons, erasers, fabric, tissue paper, sponge and modelling clay for students to compare.
9. Mass is a property of matter that identifies objects.	(a) Observe that mass is a property that identifies objects.	Use pairs of bags containing different numbers of rocks, books or other objects to introduce the terms *heavier* and *lighter.* *Starter Activities: Balancing Things* (Macdonald Educational).
	(b) Compare objects in terms of their weight.	Milk cartons with elastics attached make simple scales.
	(c) Classify the same set of objects two or more ways in terms of colour, shape, size, and texture.	Provide students with sets of objects. Within the set, each characteristic should be exhibited in three different ways, e.g., one or more of three sizes, one or more of three colours, etc.
		 Milk Carton "Balance" elastic secured stick milk carton teacher's desk white paper with scale taped on side of desk ruler elastic milk carton desk
10. Objects can be compared, ordered, and classified according to the degree to which they possess a single property.	Identify the characteristic by which objects are grouped.	
	(a) Compare and order on the basis of size.	Take three different-sized triangles and demonstrate order from small to large and from large to small. Then have the students perform the same operation using other sets of shapes, e.g., circles.
	(b) Compare and order on the basis of length.	Sticks of the same width and different lengths, e.g., Cuisenaire rods.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(c) Compare and order on the basis of width. (d) Compare and order on the basis of mass.	Gather a number of sticks of the same length and different widths, (e.g., dowelling), and order them according to width. Order three paper or cloth bags with different quantities of sand or marbles.

Earth, Space, and Time: Size and Position of Objects.

Main Concept: The position and size of an object can be described in specific terms.

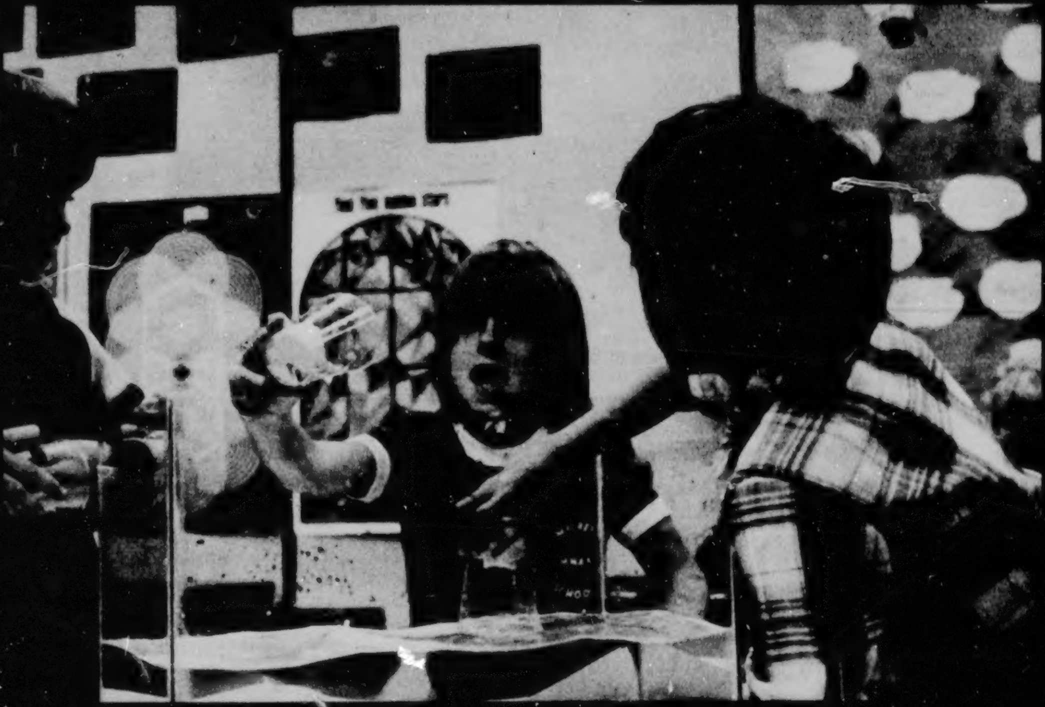
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. The position, size and direction of an object can be described by the terms up/down, forward/back, left/right, short/tall, in/out, near/far, and above/below. 123	**Students should be able to:** (a) Demonstrate and communicate the following relative positions, sizes, and motions: up/down, forward/back, left/right, short/tall, in/out, near/far, and above/below.	Punch balloons and balls up/down, forward/back and right/left. Play the game, "Simon Says". Use circles and other objects and have students respond to directions, e.g., place the large marble in the circle. Have a marching band go right/left, in/out. Have students drive a toy car up/down, in/out. Have the class do body movement activities using direction words. Note: These activities can be repeated with minor variations. Music: Sing along with Hap Palmer records. Physical Education: Have students move through an obstacle course in response to oral directions (up, in, left, right, over, under, etc.) 124

Earth, Space, and Time: Time and Events.

Main Concept: Time can be measured in terms of short and long intervals, and in terms of repitition of events.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Events occur over varying periods of time.	(a) Distinguish between long and short time intervals.	Use different sized containers of the same shape, a water source, and the sink. Students estimate which containers will take longer to fill and record their answers. Have students fill the different containers from a constantly flowing water source as they sing a short song. Students begin the song at the same time that each container begins to be filled and stop when the container is filled. Note the word at which the container is filled.
	(b) Compare the speed of objects and events.	Have a race between children crawling and walking. Have children button and zipper up jackets.
	(c) Order events chronologically.	Read a story. Have students act out events in sequence. Provide students with pictures of a sequence of events and have the students place the pictures in order. Art: Paint pictures of morning, noon, night. Language Arts: Sequence cut out pictures (comics).
2. Time is measured in days, weeks, months.	(a) Recognize the passage of one day by observing the completion of a cycle of a day.	Have students act out certain day-time and night-time events such as getting up, going to school, dinnertime, etc. Music: Sing "This Is The Way We Brush Our Teeth" (tune—Here We Go 'Round The Mulberry Bush).
	(b) Recognize the passage of one week.	Make a picture clock.
	(c) Recognize the passage of one month.	Make a monthly calendar with student's birthdays, the weather, and school events. Study the seasonal changes occurring. Make a game with a picture for each season and smaller pictures which may be sorted. Autumn stories *(Here and Now Stories) Seasons*, by John Burningham; *Now It's Fall, I Like Winter, Spring is Here, On A Summer Day*, by Lois Lenski.

Grade One



Grade One

The grade one science program is based on three themes taught in four units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
  Unit 1 Living and Non-living Objects
  Unit 2 Ourselves
Theme 2 **Matter and Energy**
  Unit 1 Properties of Materials and Change
Theme 3 **Earth, Space and Time**
  Unit 1 Comparing and Measuring Objects and Events

The above units constitute the core of the program at this grade level Some extension topics and/or extension objectives have been suggested. A sequenced statement of core concepts and processes is found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in any given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled ***Process Development*** which begins on page 13 and continues to page 1[illegible]. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

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Grade One

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Living and Non-living Objects	1	1	1	Like and Unlike	Animals in the Classroom Eggs and Tadpoles Growing Seeds Life of Beans and Peas
Ourselves				Early Experiences Ourselves Coloured Things	
Properties of Materials and Change	1	1	1	Change Working with Wood Early Explorations	Primary Balancing Changes Attribute Games and Problems
Comparing and Measuring Objects and Events	1	1	1	Time	
EXTENSION UNIT Mobiles				Change: Stages 1 and 2	Mobiles

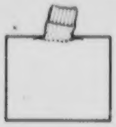
Supplementary Reference Section

UNIT	EDS	EYE	ESSP	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Living and Non-living Objects	Plants in the Classroom	Ecology in Your Community		1	1
Ourselves					
Properties of Materials and Change	Nature's Part in Art Tile Patterns and Graphs		A/1	1	
Comparing and Measuring Objects and Events				1	
EXTENSION UNIT Mobiles					

Grade One

Interdependency and Interaction among Organisms: Living and Non-living Objects

Main Concept: Objects can be classified as living and non-living according to certain properties.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Objects have certain properties.	(a) Observe, describe, explore, and classify objects according to their properties, i.e., size, colour, shape (review of kindergarten).	Place a number of objects on a tray. The students describe what is seen and felt. Classify the results either orally or in chart form. Game: Think of an object and describe its properties. Students guess the object (I Spy). Use "feely" bags/boxes. Students describe what they are feeling and try to guess what the object is *Feely Box*  Cut off the cuff of a large sock and insert the edges through a hole in the top of a box. Staple the cuff to the edges of the hole. Attribute blocks or parquetry can be used for size, shape, colour properties.
2. Objects are living or non-living. (a) The characteristics of living objects are: (i) they need food and water, (ii) they grow, (iii) they die, (iv) they reproduce.	(a) Observe live objects and discuss their characteristics, e.g., living objects need food and water, grow, reproduce, and die.	Make and/or take care of a terrarium, an aquarium, or a small animal. Discuss and list the needs of the plants or animals. Terrariums can be made using empty jars sealed with plastic covers and elastic bands. Note: The teacher must explain that a terrarium is an environment in which plants are grown. Make individual calendars for recording. Graphs can be made by students about their terrarium. Terrarium: A miniature garden grown in a container, an atmosphere which provides most of its own water. The terrarium is protected from dirt, disease, dryness, because the container is sealed. Language Arts: Intergrate with Ginn Level 1. *How To Make Terrariums* (Ginn).
	(b) Define a living object.	As a group, discuss the materials needed to set up terrariums and establish an area for the students to make them. Label jars with the students' names. Students draw pictures to accompany words–earth, charcoal, plants.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Use African violets, spider plant, chives, Ivy, parsley, mosses, aluminum plant, seedlings, grasses, ferns; decorate with rocks, shells, small pieces of wood. Only one or two slips can be put in a container. A group terrarium may be made in an aquarium. Make a chart with pictorial instructions and hang it in the activity area. The aquarium, filtered or non-filtered, can be the responsibility of another group. Research with the teacher may be done using very simple science books so that a list of necessary items can be compiled (charcoal, gravel filter, etc.). Pictorial instructions should be made. Students can make books containing pictures of their activities. Snails can be kept in a large jar of water with plants and gravel. Lettuce, celery tops, spinach or leaves can be fed to the snails. Moisture must be present on these leaves so that the snails do not dehydrate. Have students locate the tentacles, shell mouth, etc. Snail races can be held Physical Education: Imitate snail movement Draw snails showing physical characteristics. Nature Studies for Early Childhood p. 41-3.
(b) The characteristics of non-living objects are: (i) they do not need food or water, (ii) they do not grow, (iii) they do not die, (iv) they do not reproduce.	(b) Define non-living objects.	Discuss the concept of a non-living object. Define what non-living means. To confirm the students' understanding of the concept of non-living objects, have them bring various objects to school (rocks, glass). Establish a place for the objects to be put. It should be labelled with both classifications (living, non-living), so that students may discuss and classify the objects that arrive. As students gather their own rocks, activities may be done in art with them. Decorate rocks: Make animals out of them; paint faces on them to distinguish members of a rock family (father, mother, etc.). Name objects in the class/school which are living or non-living.
	(c) In order to establish the properties of the non-living objects, compare living objects to non-living objects on the basis of growth, need for food and water, and reproduction.	List the properties and discuss how objects differ: animal and non-living object; plant and non-living object. Art: 1. Show examples of living and non-living objects in a mural. 2. Make a scrapbook.
134	(d) Observe that fruits produce seeds.	Cut up a variety of fruit. Examine the seeds and discuss findings. Make seed mosaic pictures.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(e) Compare and classify seeds on the basis of large and small. Observe and compare the growth of different seeds and make a simple bar graph showing their growth.	Give students a number of seeds on a plate. Sort into like groups. Examine with a magnifying glass. Plant two small seeds and two large seeds. Observe the results. Record the growth of the plants by cutting a strip of coloured paper to correspond with the height of each plant. These strips may then be labelled according to large or small seed size and mounted on a white paper to form a bar graph.
	(f) Compare plants with non-living objects.	Grow seeds, discuss their needs, and chart their growth. Discuss the properties of plants as living organisms. Compare to non-living green objects and objects with other properties.
	(g) Hypothesize about the form and shape of an adult plant when using cuttings from another plant. Note: The parent plant and cutting will be identical plants.	Plants such as coleus, wandering Jew, patience plant, geranium, English ivy, are easily grown in a classroom. *Starter Activities: Growning Things Indoors* (Macdonald Educational).
	(h) Classify objects into living and non-living groups.	Field trip: Examine the school yard. Chart observations and explain why the inhabitants are living or non-living.

Interdependency and Interaction among Organisms: Ourselves

Main Concept: There are variations and similarities among human beings.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. People's height, weight, and shape vary.	**Students should be able to:** (a) Observe and discuss the differences in body height, weight, and shape.	Have the students trace each other's shape onto large sheets of brown paper or graph paper. Then each student draws the head, face, hair, clothing, etc., on the outline. A full length mirror will help in this activity. This figure is then painted, cut out, and hung in the room. Discuss the various shapes which have appeared and compare the height of individual brown paper people. Note: Teachers should take care that students do not become concerned about personal comparisons. Art: Have students paint this figure and cut it out. (These figures may be displayed in the classroom).

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integratio
	(b) Measure and compare the height and weight of people.	On graph paper or the wall, make a chart for measuring height. Use the metre stick to mark off cm levels, having students call out levels as high as they can go. Finish the chart with them by telling them the higher numbers you are writing. Tell them that is is important that they listen to these numbers because you think that most of them will have these numbers for their height measurement. Demonstrate the measurement of height by having a student stand against the wall chart. State the height. Have the students measure one another's heights in this way and record the heights on the wall chart. Have the students weigh themselves on a kilogram scale. Record their weights. Post the height, weight, and name of each student on a stip of paper under his painted picture. Language Arts: Make "All About Me" booklets in which students print simple sentences describing personal characteristics (e.g., I am 100 cm tall) and draw accompanying pictures. Read *The Growing Story* by Ruth Kraus.
	(c) Graph and record information.	If graph paper were used in tracing the bodies, the students can compare their height by counting numbers of squares. The height and weight of the students may be recorded on two separate graphs. These are simple bar graphs on which is printed each student's name and his weight in kilograms and height in centimetres. A single crayon colour is used by all the students. They must look for their name and measurement number at which level a small pencil line is made. The bar is then coloured in from the pencil line to the bottom. Discuss resulting graphs and any comparisons children may make. An alternative type of bar graph could consist of strings, cut to the students' heights, labelled, and hung vertically on a coloured background.
2. Heads vary in size and shape.	(a) Observe and classify head shapes.	Draw face profiles and full face views. Classify. Art: Use bright light, such as that from an overhead projector, to create a shadow profile of each student. Trace each profile on white paper, cut it out, and mount it on black paper. (This art project makes a lovely gift for parents).

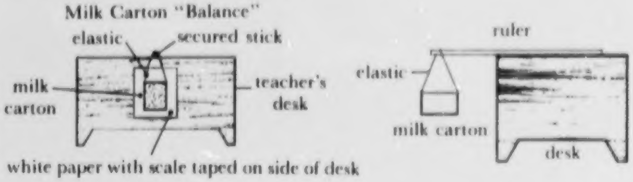
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Measure and compare head sizes.	Measure heads with tape measure or paper strips. Take random samples of head sizes. Classify those sizes which are the same or very close in measurement. A graph may also be done for this.
3. Eyes vary in colour.	(a) Observe differences in eye colour.	Count the number of students with blue eyes, brown eyes, etc. Make a graph to show distribution of eye colours.
	(b) Classify and graph eye colours.	Make a chart of parent's eye colour in relationship to eye colour of child. Discuss findings. Although brown-eyed children often occur from brown-eyed parents, blue-eyed children are possible because recessive characters are present in the parents. Note: Be careful of reactions of adopted children.
4. Ears vary in shape.		Have students examine each other's ear lobes to determine types. Language Arts: Read Walt Disney's *Dumbo*.
5. Hair varies in shape and colour.	(a) Classify types of hair as to colour and straightness or curliness. Graph.	Survey the hair colour of class members. Graph results. Have each student decide if his or her hair is curly or straight Chart results. Devise simple experiments to test the strength of each student's hair.
	(b) Classify the children on the basis of hair and eye colour and infer the relationships between hair colour and eye colour.	Have each student list his or her hair colour and eye colour on a card. Put like cards in one pile. Chart results and discuss any relationships discovered. Game: Some students hide behind a counter, revealing only their hair to the rest of the class. Others try to guess their identities.
6. Legs and feet vary in size, shape and strength.	(a) Measure and compare the length and width of feet.	Measure the students' feet by using a ruler and by tracing onto graph paper.
	(b) Observe differences in foot shape.	Sprinkle the bare foot with powder and step on black paper. Observe differences in foot prints. Put several barefoot children behind a screen with only their feet showing. Do boys' feet differ from girls' feet? Mathematics: Integration. Art: Make feet pictures portraying people from various "walks" of life. Make "foot fellows" by tracing shoeless feet and decorating with buttons, material, wool, etc., to make animals, machines, and faces.
	(c) Measure and compare leg power.	Put a large sheet of white paper on the wall. One student inks fingers, then jumps as high as possible and puts finger

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		prints on the paper. Record names on the prints. Is there any general difference in the height of boys' and girls' jumps? Language Arts: Read "Walking" by Grace Ellen Glaubitz in *Time for Poetry* by May Hill Arbuthnot.
7. Arms and hands vary in size, shape and strength.	(a) Measure and compare finger length.	Trace finger outlines on paper. Measure length. Discuss differences in their length.
	(b) Measure how large the hand is.	Pour water into a clear container and mark level with tape. Place hand in container. Note the differences in water level.
	(c) Measure the strength of the arm.	See how long a student can hold up a heavy object in each hand. In which hand can he hold it longer? Discuss.
	(d) Observe and compare differences in finger prints.	Ink fingers on a stamp and make finger prints on a sheet of paper. See if prints are the same for both hands. Compare prints of several students. Art: Use thumb prints to make animals, flowers or patterns.

Matter and Energy: Properties of Materials and Change

Main Concept: Change occurs when the properties of objects (matter) are modified. Changes occur constantly throughout the environment in observable patterns of order and time.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Review properties of objects (kindergarten). Properties of objects are examined further in order to develop classification skills and the ability to compare objects on the basis of one property.		Discuss objects using their properties to describe them i.e., size, shape, colour.
2. Objects (solids) can be distinguished by physical properties such as colour, size, mass, and shape (solids retain their shape).	(a) Describe objects in terms of properties.	Use common objects found in pupils' pockets and describe their properties.
	(b) Identify objects on the basis of descriptions of their properties.	Name specific properties of objects and ask students to identify objects, e.g., can you find an object which is blue?

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(c) Compare masses of objects.	Set up balances and have students compare masses of balanced objects. Hang a milk carton by elastic bands from a secured stick (see diagram).  Milk Carton "Balance" elastic secured stick milk carton teacher's desk white paper with scale taped on side of desk ruler elastic milk carton desk
	(d) Classify a group of objects on the basis of single properties. Graph.	Have students put objects into their sets or categories on the basis of one of the following criteria: colour, living, non-living, or number of corners. Graph.
	(e) Identify the basis on which sets of objects are classified.	Put objects into sets according to two properties: round and yellow, round and red, square and red. Have students state the properties that are the basis of the classification. Attribute Blocks and People Pieces may be used for sorting.
	(f) Identify multiple properties in single objects.	
	(g) Classify objects (solids) on the basis of two properties.	
3. Objects (solids) differ in texture, hardness, and weight.	(a) Compare a specific property (hardness, texture, weight) in pairs of objects (solids).	Discuss the ways in which objects (solids) differ: texture, hardness and weight. Look at pairs of objects and compare them as to softness (when looking at a sponge and a stone), smoothness (a cactus and a leaf), weight (a feather and a book). Language Arts: Read and have students examine *The Touch Me Book* (A Golden Touch and Feel book).
	(b) Compare three objects (solids) to determine the degree of a specific property.	Look at three objects and order them on the basis of texture, weight, and hardness (e.g., hardness would include a penny, pencil, modelling clay).
4. Change occurs where the properties of objects (matter) are modified.	(a) Observe and identify objects that have had properties changed.	Discuss the concept that change occurs when properties of objects (matter) are modified. The concept of change can be introduced through various observations over a period of time, e.g., moistened bread in an open jar, dry bread and an apple in an open jar, concentrated sugar solution.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Observe and identify changes in properties (solids) such as shape, size, and colour on the basis of evidence.	Groups of students can be given plastic bags, aluminum plates or other containers holding such things as crushed potato chips, grated carrot, confetti (or paper from a paper punch), white chalk dust, crushed hard candy, minced coloured and white chalk, pencil shavings. Samples of the original objects, e.g., whole potato chips or whole carrots are retained. Students are asked to identify the objects in the bags by matching them with the whole objects. Students can then be asked to identify those objects which changed in such properties as colour, size, shape. Game: Have students bring to school mystery objects which have already undergone change. Students guess the identity of each object.
	(c) Describe evidence of change in form and colour (of solids).	Give modelling clay of two different colours to students to roll and flatten, break into parts, and mix. Have them identify changes in specific properties. Art: Have students mold modelling clay animals, etc. Let dry. (These can be given as gifts.) A rotting log can be compared to one which is not rotting. Provide rubber bands, cardboard squares, paper clips, and similar materials and ask students to identify possible changes in size or shape.
	(d) Describe changes that are observed in objects.	Provide pictures which illustrate changes in form and colour and ask students to describe the property changes.
5. The properties of objects (solids) will change when water is added.	(a) Observe, identify, and describe changes in the properties of solids and water.	Select objects which change readily on contact with water (e.g., sugar, soil, soft-drink powder, tissues, crackers) and objects which do not change or which change slowly (buttons, wood, spaghetti, celery). Add water and observe changes. Provide samples of the dry materials for comparison. Art: Mix chocolate pudding/pie filling powder with water (in the quantities specified for milk on the box). Do chocolate pudding finger painting. Use manilla tag tracers to draw fairies on dried pictures. Cut these out and display. Make gelatin dessert and have students observe various stages of solidifying. (Use one cup of water with package). Present pictures which illustrate changes in properties of solids added to water. Ask students to identify the changes, e.g., package of drink crystals and glass with mixed drink, dry paper towel and wet paper towel.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Predict changes which will occur when water is added to some solids.	Rice, nickels, paper, soap powder, salt, tempera paints, and cookies can be provided. Ask students to suggest possible changes which will occur when water is added. Have students test their predictions.
6. Changes in properties of objects (solids) can occur when the objects are heated or cooled.	(a) Observe changes in properties of objects (solids) when objects are heated or cooled.	Demonstrate popping corn using an electric frying pan. Sit students around the edge of a sheet and allow kernels to pop and fly. Other activities: Make apple sauce, a gelatin dish, popsicles; have students hold a small square of chocolate in their hands; cook eggs, place a bowl of ice cream on a table (use spoons for "clean up"); put some of the ice cream back in the freezer; burn a small piece of paper or a wooden splint. Ask students to observe, describe, and compare changes in the heated and cooled objects. Art: Use popcorn to make snowmen, rabbits. Math: String popcorn with one or two other objects so that patterns are developed. Language Arts: Have students read and follow the recipes for gelatin dishes and popsicles.
	(b) Infer the reason for change by comparing changed objects (solids heated) to the originals.	Provide pictures or samples of unpopped and popped corn, bread and toast, cake and cake dough, burned splint and unburned splint, and other materials. Students match changed and unchanged materials and describe the properties changed.
7. Some changes occur in a regular pattern and can be ordered.	(a) Compare and order pictures which illustrate changes.	Groups of three pictures, out of sequence, can be ordered by the students. Examples could be ice cubes melting, food being prepared, pictures of growth, clothes washed and dried.
8. Some changes are more easily reversed than others.	(a) Discriminate between changes in terms of ease of reversal.	Easily reversed changes (e.g., move a chair back and forth, open and close a door, inflate and deflate a ballon) and less easily reversed changes (e.g., break chalk, tear paper, sharpen a pencil) are presented. Students are asked to identify the changes in properties which can be easily undone or not easily undone. Pictures of change can be presented and students asked to indicate those changes which can be easily reversed or not easily reversed.

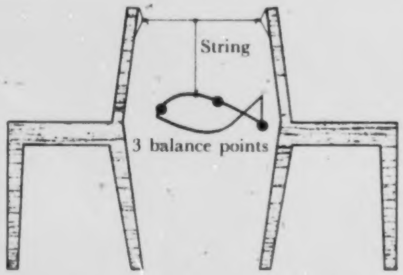
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
9. Weather can exhibit different kinds of change.	(a) Observe changes in the weather and infer whether they are rapid or gradual.	Have students make a weather record from Monday to Friday. Use the following criteria to record the weather: sunny/cloudy, windy/not windy, dry/rainy, and cold/warm/hot. At the end of the first week, have them predict Saturday's weather according to what they observed during the week. Do this until the end of the third week at which time they may predict the weather for the whole weekend. Some students may want to predict the weather every day after the first week, and other may want to predict the weather for the entire week after predicting for three weeks. Emphasize that the important thing is the basis for the prediction and not whether the prediction was correct. Language Arts and Art: Have students listen to tape recorded sounds of wind or rain or a hot, still summer day. Have students write a group composition and/or draw pictures in response to the listening experiences. Art: Make rain pictures. Draw or paint rainy-day scences on white paper and cover with very thin plastic wrap. Language Arts: Read poems from "Wind and Water" section of *Time for Poetry* by May Hill Arbuthnot.

Earth, Space, and Time: Comparing and Measuring Objects and Events

Main Concept: Objects can be compared, described, ordered, and measured on the basis of arbitrarily chosen reference points and non-standard units.
Events occur in a particular order or sequence and last varying lengths of time.
Events may be regular or irregular in frequency.

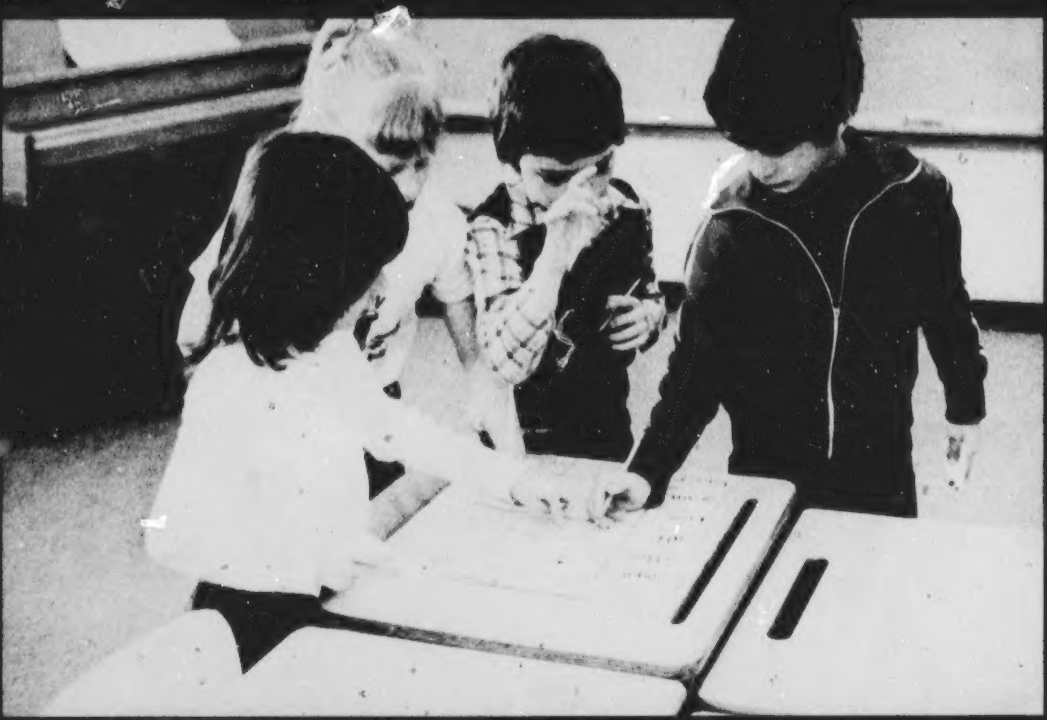
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Objects can be compared and ordered by size by using non-standard units.	(a) Compare sizes as large/small.	Use terms (large, small) to compare sizes of objects in pictures.
	(b) Compare size of objects to different arbitrary standards.	Use any object with a range of sizes, e.g., beans, buttons, and compare with an arbitrary standard, e.g., paper clips, brushes.
	(c) Measure objects with arbitrary units.	Ask students to compare the size of two similar objects. Then try measuring using a stick or string. Try more "regular" units in another measurement exercise. Discuss reasons for standard units and try them out by measuring various objects. Mathematics: Integrate vocabulary and measurement skills.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. The position of an object is determined relative to arbitrarily chosen reference points.	(a) Observe that, to determine the position of an object relative to an arbitrarily chosen reference point, the position of the object must be described. Use terms, above/below, front/back, up/down, far/near.	Use a toy animal and other objects which you move in relation to the toy. Play "Do This—Do That". Physical Education: The same type of game can be played or the teacher can stand at one point and have the students respond to far/near command. Switch, using individual students or points within an area as the foci of the activity. Play the game "Frog on the Log". Use a spinner with position and colour markings on it and corresponding squares and circles placed on the floor. One student is appointed the frog and sits on the log to spin the spinner. He or she tells the first student in line to take the position the spinner indicates. If it spins to the log, students change places. Continue until all spaces on the floor are filled. Repeat.
	(b) Measure distance in arbitrary units.	Hold objects far from and near to reference points. Describe the position using the suggested terms. Game: Have students bring small cars and trucks to school. Have each car travel down an incline plane across the floor. Measure distances travelled, chart, and compare.
3. Events may be of short or long duration.	(a) Observe the length of events.	Burn short and long candles of the same thickness. Graph results. Melt ice cubes of different sizes and observe the duration of each race. Race "Hot Wheels" game on different lengths of track.
	(b) Predict the comparative durations of events.	Predict and verify the difference in time between opening the zipper and buttons of a coat.
4. Changes may occur over different time periods.	(a) Observe and compare changes in objects over time.	Have students observe and compare changes in cut fruit, mixed cement, bean in water and dry beans, nail in water and dry nails, over a period of time.
	(b) Estimate periods of time from pictures.	Observe that growth and change occur in humans and animals. Have students estimate the length of time between changes (e.g., pictures of summer and fall, plants growing, ballons breaking). Baby picture contest: Set up a pocket chart and number the baby pictures. Have students guess the identity of the pictures and give reasons for guesses.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
5. Events may be regular or irregular.	(a) Observe events for regularity or irregularity.	Perform a variety of activities to observe regular or irregular repetition. Observe events for regularity. Use a pendulum, see-saw, regular tapped beats, second hand of clock (regular), popcorn in pan, traffic on street (irregular).
6. Events occur in a regular time sequence (days, weeks, months, seasons).	(a) Sequence events.	Use sequenced pictures, comic strip sequences. Play—"Let's Pretend" to illustrate the concept of sequence, e.g., Let's pretend we are getting up in the morning. Sequential Picture Cards 1 (Developmental Learning Materials). Music: "I am a Paper Clock."
	(b) Record time spent at tasks.	Make a chart of each day's activities.
	(c) Compare different regular time sequences.	Name and record recurring events, e.g., weekends, T.V. programs (repeated weekly or daily), day-night sequence. Language Arts: Read poetry from "Round the Clock" and "Round the Calendar" sections of *Time for Poetry* by May Hill Arbuthnot.
Mobiles—Extension Unit	**The student should be able to:**	
1. Objects will balance about a support (fulcrum) if forces on both sides of the support are equivalent.	(a) Balance a single mobile piece.	Discuss mobiles and show some examples. Provide students with a single mobile piece (bird, fish, human shape) with three location points on it and have them hang it on a wire or string which is attached to two chairs. Have students make and balance their own shapes. 
	(b) Predict the location of the balance point when adding parts to a single mobile piece.	Provide students with a single wing for the bird or fin for the fish. Have them predict the new location point and balance the mobile piece. Repeat with two wings or fins.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(c) Balance a single rod mobile.	Provide students with two equal shapes and a wooden rod. Repeat using shapes of different sizes. Students may wish to experiment with balancing the rod and one mobile piece on their fingers initially. Rods can be made of wooden dowelling about ½ cm in diameter. Stiff wire is also satisfactory. This will develop the idea that the balance point need not be in the middle of the rod. Repeat with three pieces.
	(d) Construct an original mobile design.	Single rod mobiles can be balanced from a string rather than a finger. Provide students with three or four rods and sufficient manilla tags or construction paper and string. The concept of symmetry can be developed. Students can be provided with materials and asked to predict how they can be used to build a symmetrical mobile. It is likely that both symmetrical and asymmetrical mobiles will be produced. Methods of changing symmetrical into asymmetrical mobiles can be discussed.

Grade Two



Grade Two

The grade two program is based on three themes taught in four units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
  Unit 1 Properties of Living Objects
Theme 2 **Changes in Matter and Energy**
  Unit 1 Properties of Matter
Theme 3 **Earth, Space, and Time**
  Unit 1 Measuring Time
  Unit 2 Measuring Objects and Position

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested. A sequenced statement of core concepts and processes is found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled ***Process Development*** which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Grade Two

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Properties of Living Objects	2	2	1	Minibeasts	Pond Water Animals in the Classroom Eggs and Tadpoles
Properties of Matter	2, 1	2, 1	2	Metals	
Measuring Objects and Position	2	3	2	Ourselves	Match and Measure
Measuring Time	2	2	2	Time	
EXTENSION UNIT Properties of Materials: Sand				Change: Stages 1 and 2 Early Explorations	Sand

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	SCIENCE IN ACTION	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Property of Living Objects	Vacant Lot Study Plants in the Classroom Nature Hunt Nature's Part in Art	The Dandelion Ecology in Your Community	A/1	Studying Birds Studying Insects Studying Mammals Studying Plants	1	2
Properties of Matter			B/2		2	1
Measuring Objects and Position					1	
Measuring Time					2	
EXTENSION UNIT Properties of Materials: Sand						

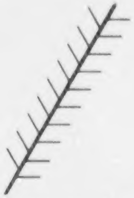
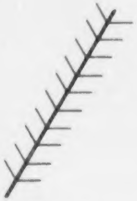
Grade Two

Interdependency and Interaction among Organisms: Properties of Living Objects

Main Concept: Living organisms exhibit unique properties.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Objects can be classified as living and non-living (review of grade one).	(a) Classify and identify objects as living or non-living.	Discuss the way a store is organized. Discuss possible reasons for this organization. Ask students to look about the room and suggest classifications (ways of grouping) for the objects found there. Introduce the classification of living and non-living. Allow students to suggest objects which they think may belong in these classifications. Discuss. Integrate Mathematics: Like and unlike sets. Classify other objects in the room to reinforce the idea of living and non-living objects. Make a chart divided into columns labelled "living" and "non-living". Students can place pictures they have found in magazines as well as the names of the objects on paper strips in these columns. "Let's take a walk". Collect objects in boxes or jars and classify into living and non-living. Discuss. Classify objects in an aquarium, pond, river, farm. Go on a scavenger hunt. Students have a specific list of living and non-living objects to find. Language Arts: Nature hunt. Make a chart of adjectives describing some of the things you have collected. Use the words in creative writing activities.
2. Living organisms can be classified according to properties (review of grade one).	(a) Identify some properties of living organisms (grow, need food, water, air, light).	Discuss to which classification human beings belong (living non-living). Discuss what we need to keep alive and record the ideas on chart paper. Social Studies: Community helpers; inter-dependence. Discuss other living organisms and see if they have any of the same properties. Compile a list of properties on which students agree, based on the needs of living objects. Measure a growing object over a period of time. Keep a record.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Have students bring an article of clothing they wore last year. What has happened? Language Arts: Make a filmstrip projector from a shoebox and wax paper rolls. Students will research topic and make filmstrip. Social Studies: Have a baby picture contest.
	(b) Identify properties which are unique to each of the following six animal groups: mammals, birds, reptiles, fish, insects, amphibians.	Post the names of the six groups on a chart or on the blackboard so that properties can be listed. Members of these animal groups can be listed below the properties. Have pictures available for each animal group in case the students cannot think of any examples. These pictures will also aid in discussing the characteristics of the animals. Note: The distinction between amphibians and reptiles is difficult for children at the grade 2 level to understand and need not be stressed. ***Definitions*** Amphibian: Any cold-blooded vertebrate of the class ***Amphibia*** comprising the frogs, salamanders, and caecilians, the larvae of which are typically aquatic breathing by gills and the adult of which are terrestrial breathing by lungs and through the moist glandular skin. Reptile: Any cold-blooded vertebrate of the class ***Reptilia*** comprising the turtles, lizards, snakes, crocodilians.
	(c) Record data on individual animals in each of the six identified groups.	Group students or decide on individual projects. They must choose one of the six animal groups to work on and an animal within that group. Books should be available in the library. Library: Show the students how to use the card file and how to find material in the library. Decide in what form to record the data and what questions are to be answered.
	(d) Communicate information on individual animals.	Set up times for students to display their reports, share their information, and ask questions about the animals. Choral speaking activities and dramatic play will help students gain confidence in speaking publicly.
	(e) Define operationally each of the six animal groups.	After the research and sharing of information, certain properties of the animal groups will be evident. These properties should be used to form definitions which the students understand.
	(f) Classify animals according to groups.	Have students draw or find pictures of animals which may be used on a wall chart. This chart may include other animals in addition to those researched.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(g) Identify properties which distinguish deciduous trees, conifers, shrubs and small plants.	Discuss with students the parts of their body which help them each day (arms, head, legs, feet, hands, etc.). Look at several plants and identify the parts of a plant (leaves, stem, flowers, roots). Take a walk in your neighbourhood to identify deciduous trees, conifers, shrubs and small plants with students. Identify properties which are common to deciduous trees, conifers, shrubs, and small plants. Have students draw one big plant and one little plant. Label the pictures and display under "big" and "little" headings. A detailed study of a plant may be done, e.g., dandelion. See *Native Manitoba Plants,* Department of Agriculture, Manitoba. Common Manitoba deciduous trees: Oak, Elm, Manitoba Maple. Conifers: Jack Pine, White Spruce, Black Spruce. Shrubs: Raspberry, Red Currant, Gooseberry, Blueberry, Mountain Ash (large shrub), Common Juniper, Creeping Juniper.
	(h) Identify leaf patterns on deciduous trees, conifers, shrubs and small plants.	Show students that many trees have leaflets making up the leaf rather than one leaf by itself. Collect examples of alternate and opposite growth patterns.  Alternate  Opposite
	(i) Classify the leaves collected according to leaf pattern.	Discuss collected leaves and classify according to leaf patterns. Chart. Students can also check the leaf patterns of plants at home and add this information to the classification chart. These leaves can be pressed and ironed between wax paper or put between clean mac-tac and labelled. Students can then refer to these examples. Art: Make leaf prints, spatter paintings and rubbings.
3. Living organisms respond to external stimuli.	(a) Observe how living organisms react to stimuli such as touch, sound, light.	Touch an animal. Touch another person. What happens? Squeeze a leaf. What happens? Discuss what you would do to get a person's attention if you could not make a sound or touch him/her. Tap on an aquarium. Observe fish. Stress that this should not be done by students at any other time. Call an animal. Note its reaction. "Talk" to someone but do not use your voice.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Bang something very loudly and discuss the students' reaction to the sound. Discuss with students what kind of world it would be with no light; sunlight for a few hours; sunlight for many hours. Physical Education: Children sit in a circle. Send a stimulus around, e.g., a hand squeeze. Time how long it takes for the stimulus to reach the end of the line. Repeat three times. Mathematics: Graph results of the above activity. Discuss what happens at night when a light is on and the insects are out. Check under rocks or wood on the grass to see what is underneath. Discuss the reaction of insects living under the rocks to a light appearing. Train fish to respond to certain stimuli. Dilation of the pupil of the eye can also be attempted with the students. Reactions can be observed when a student moves from a very dark area to a brighter one or from inside to outside on a very sunny day. The students should observe the pupil before the experiment starts and record how the pupil reacts to the stimuli.
	(b) Observe that the direction in which a plant grows is affected by external stimuli.	Conduct a seed growth study. Plant bean seeds in various positions. Observe. Carrots, avocado, and onion may also be used. Grow plants in light, in a cupboard, planted upside down, sideways. Scholastic: *The Carrot Seed* (Record and book) *My Garden Grows*, by Aldren Watson
	(c) Identify the changes which take place in the environment in response to seasonal stimuli.	Discuss with students the four seasons of the year. Identify the changes which take place in the environment during these seasons. Record the students' ideas on change under each identified season.
	(d) Identify and classify the responses that plants make to seasonal stimuli.	Discuss the changes in deciduous trees in response to seasonal changes. Students should note that plants do not die but have a dominant or resting period during the winter. Have students dig down in the snow to see if the grass is still there but not growing.
	(e) Identify and classify the responses that animals make to seasonal stimuli.	Discuss using pictures, filmstrips, films and books such animal responses as: hibernation, migration, molting, food storage (inbody fat and external hiding places).

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
Extension	(f) Identify the responses which living objects make to negative environmental stimuli, e.g., littering.	Take a walk around your school community. Note examples of littering. Discuss responses of plants to littering, e.g., dead grass beneath litter. Discuss responses in animals to littering, e.g., animals cut by broken glass.
4. Plants differ from animals in how they obtain food, react to stimuli, and move.	(a) Identify some of the differences between plants and animals: most animals have locomotion but plants do not; plants produce their own food but animals do not; most plants are green but most animals are not.	Construct an aquarium or a terrarium. Develop criteria to decide which objects are plants and which are animals. What are some of the properties of the plants and of the animals (e.g., colour, legs, movement). Chart. Make a trip to a small pond, stream or ditch. Collect specimens, using jars and small nets. Classify organisms according to criteria established. Follow the trail of a wet snail over a blue paper. Record. Develop a class book on ways of moving. Social Studies: Transportation Language Arts: Communications Creative Drama: Imitate the movement of various animals.
	(b) Predict plant movement in response to stimuli.	Plants may be exposed to a variety of stimuli, e.g., heat, cold, light, touch. Place two plants in a closed box with a hole and place another plant beside the box. After watering, leave the plants for one week. Predict what will happen.
5. Plants live in many different habitats in an environment.	(a) Observe that plants live in many different habitats in an environment: soil/tree; water/water lily; rock/trees; moss/lichens.	Examine several plants (actual and in pictures). Identify the conditions which help them to grow (heat, water, shade, etc.). Transplant some plants into another environment and observe what happens: grass kept in cupboard; grass watered; and grass not watered. Habitat: The place where an animal or population normally lives.
6. Plants require nutrients. They obtain them from the water, air, and soil. Green plants require light to make food.	(a) Observe and describe what happens to plants when deprived of water or light and when placed in cold temperatures.	Place two plants of the same kind in sunlight. Water only one. Observe what happens over a period of time. Take two plants of the same kind. Put one in sunlight and one in a dark room or box. Water. Observe what happens. Place one plant in the freezer, one in the fridge, one in a closet. Observe.
	(b) Observe and describe the effects of different soils on seed growth.	Plant radish seeds, alfalfa sprouts or grass seed in soil, clay, sand, peatmoss, pebbles, or marbles. Water each group the same amount and observe.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
7. Animals live in many different habitats in an environment.	(a) Identify the habitats.	Have students name various animals. List. Show pictures of different animals, e.g., fish, birds, insects, land animals. Discuss where they live. Develop a chart showing where the animals live, e.g., country, city, desert, ocean, field, forest, mountains, pond. Film: Adventures of a Baby Fox.
8. Young plants resemble their parents. Some animals reproduce young which resemble their parents. Other animals do not resemble their parents until mature.	(a) Discuss	Use pictures when discussing similarities and differences between parents and offspring.
	(b) Describe the life cycle of some familiar plants and animals: seed - tree - seed; egg - chick - hen - egg; frog - eggs - tadpoles - frogs.	Outline or draw some familiar life cycles. Groups should be assigned different cycles. Research and projects in this area may involve a variety of animals, depending on student's level. Soak corn and plant it. Observe growth and life cycle. Discuss and chart observations. Collect and observe frog eggs. Note: Add fresh pond water regularly. Illustrate stages of the life cycle. Compare to the life cycle of a cat or a dog.
	(c) Discuss those animals that reproduce young that resemble the parent and those animals whose young do not resemble their parents until mature.	Make a chart or bulletin board display of animals or plants which resemble parents and those which do not. Library research on the subject can produce books which help with the display.

Changes in Matter and Energy: Properties Matter (Solids, Liquids, and Gases)

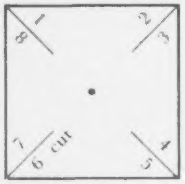
Main Concept: Objects (matter) commonly exist in three distinct forms: solids, liquids, and gases. Each form has characteristics properties.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. Review properties of objects (solids) and change (from grade one).	**Students should be able to:** (a) Identify various properties of objects.	Have a feely box or objects on a table for sorting. Children can be encouraged to bring objects which could be sorted. Objects from the room may be used so that each student can contribute one item. Art: Using objects collected, make pictures. Make collages using only one material, e.g., wood, toothpicks, popsicle sticks, bark.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. Objects are made of materials which have unique properties.	(a) Identify objects which are made of different materials.	Have a student who is "it" pick up an object and give a clue about the material of which it is made, e.g., it bends or is shiny. Students are asked to name the object. Play "I Spy". Use feely box or bags. Students choose objects in the room. Class discusses similarities or differences in objects chosen.
	(b) Compare objects made of one material and those made of more than one.	Use pictures or sets of objects which contain objects made of one or more materials. The number of materials in the set are identified and the objects are classified according to the number of materials in the object. Use a set period of time – 5-6 days in which students contribute to a changing display of objects with growing number of properties. Day 1: object with 1 property; day 2: objects with 2 properties; etc. Label each day and provide 5 minute discussion time.
	(c) Classify objects in terms of the kind of material of which they are composed.	Use pictures or sets of objects which are made of metal, wood, fabric, paper, plastic or similar materials. Objects are classified on the basis of their material. Have an interest centre for a classification game with labelled sheets on metal, wood, plastic, etc. Have material to sort out. Record or chart objects in the home or at school in specific classifications. Use chart paper or a bulletin board. Lists of home objects can be brought to school to be shared and compared.
	(d) Compare samples of the same type of material in terms of a single property.	Samples of three or four different woods can be tested for hardness by a scratch test using the fingernail or a nail. Velvet, cotton, burlap, satin, silk could be used as well. Compare strengths of different lengths of string of same thickness.
3. Solids have distinct properties: tend to retain their shape; can be stacked; can be poured only if in small pieces; retain properties when their form is changed.	(a) Identify solids in a group of solids and liquids.	Use pictures of a mixed group of solids and liquids or a single demonstration set of objects. A cup of sand and a cup of water can be poured into other containers. Sugar cubes can be crushed and poured. Students sort the objects into solids and liquids.
	(b) Be aware that different forms of the same solid contain the same material.	Modelling clay, sugar cubes, aluminum foil, candy, paper clips or similar material is provided with plastic bags and a wooden block. Students change the form of the material. Emphasize that there is no change in the material itself.

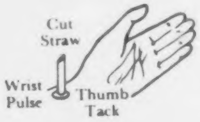
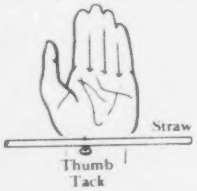
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Provide students with pictures or samples of different forms of solids, e.g., cloth and threads from the cloth, wood and wood shavings, peanuts and crushed peanuts, red pencil and pencil shavings, aluminum foil and aluminum cubes, sugar cubes and sugar grains, etc. Similar solids are matched.
4. Some solids can be classified as metals on the basis of specific properties, e.g., shininess, flexibility (bends), can be beaten flat by hammering (malleable).	(a) Observe and record some properties of metals.	Provide students with samples of copper wire or nails, aluminum wire or nails, paper clips, brass nails or similar materials. Small toy hammers and wooden blocks should be available. Properties of flexibility, shininess and malleability can be examined by the students. Other tests such as scratch tests can be applied to examine hardness. Record these properties on a class chart.
	(b) Classify objects according to identified properties.	After students have experimented with the objects and have identified their properties, provide a group of metals and non-metals for them to sort. Some objects may belong to more than one group.
5. Liquids have distinct properties: take the shape of the container they are in; can be poured; splash; form drops.	(a) Observe and describe the properties of liquids. Compare liquids to solids.	Demonstrate: Pour coloured water into bottles of different shapes. Tilt a jar of water to observe the shape of the liquid. Place single drops (by eye-dropper) on pieces of waxed paper or a number of drops into a shallow dish. Discuss observations. Pour other liquids, e.g., vinegar, cooking oil, into bottles of different shapes. Students can describe the different shapes taken by the liquids. Place a few pebbles into a shallow container. Pour sand into a shallow container. Students should compare the effect of containers upon materials. Art: Blow drops of paint through large straws to create a design. Drop blobs of paint with an eye-dropper on paper. Fold the paper. Open to see the design.
6. Liquids vary in the degree of specific properties such as colour, transparency to light, ability to dissolve sugar, viscosity, absorption ability.	(a) Observe some properties of different liquids: translucent, opaque, absorbable.	Provide groups of students with vials of clear liquid, several different coloured liquids, cooking oil, paper towelling, waxed paper, and a short soda straw. Have the students place a drop of the liquid first on paper towel, then on waxed paper. Note the colour, whether the liquids are translucent, transparent or opaque, and whether they are absorbed.
	(b) Compare and test different liquids on the basis of properties of viscosity, absorbency, and ability to dissolve sugar.	Assemble six vials (labelled A-F) of liquids such as vinegar, milk, water, cooking oil, syrup or motor oil; short straws; paper towelling; and sugar cubes. Test viscosity by stirring with the straw and allowing the liquid to drip on the towel. Note the rate at which the drops fall. Art: With eye droppers, put food colour drops on tissue paper. Vegetable oil may be used on the tissue in combination with the above or by itself. Frame the result with dark construction paper.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Discuss what is a fair trial for testing absorbency (a drop of two liquids on squares of paper towelling at the same time). Repeat for other pairs of liquids. Place sugar cubes into the vials and observe rate of dissolving. Order from fastest to slowest. Result should be recorded on the board. Liquid olympics: Use three vials with different liquids in each, e.g., vinegar, cooking oil, and corn syrup. Have students pour the liquid from their vial onto wax paper. Which liquid pours the fastest? A sufficient amount of each liquid may also be placed on a flat wax paper surface. The surface is then tilted to see which liquid would move the fastest. The liquids may be poured on paper towelling to see which liquid would produce the largest absorption circle.
	(c) Identify sample liquids on the basis of evidence.	Test mystery liquids: Provide students with pairs of liquids, e.g., water and vinegar, cooking oil and syrup. Students can test and compare properties and identify the samples by slowly pouring each of the pairs from a teaspoon at the same time.
	(d) Order liquids on the basis of properties.	Use sets of three vials of different liquids. Order them from 1-3 on the basis of colour, clarity, and ability to dissolve sugar.
7. Gases have distinctive properties: take up space; can move; and cause objects to move.	(a) Infer that gases take up space.	Take a shoe box with a lid and cut a small hole in the box. Students should note that their box looks empty. Have them push on the sides of the box and feel the air excape. Have students place solid objects (such as an eraser) in a plastic bag. Force all of the air out of the bag so that the eraser pushes against it. Put water in another bag and tie it. Blow up a third bag. Students should note that the air pushes on the bag just as the eraser and water do. Caution: Plastic bags should be collected after activity. Blow up a balloon. Students should note that the gas blown into the balloon gives it shape. Thus the gas takes up space. Test under water.
	(b) Infer that gases can make objects move.	Fold a small piece of paper and set it on the table. Observe that it doesn't move. Using a straw, the students should then blow on the paper and observe that the air they blew out moved the paper. Have the students make a pinwheel. Make a diagonal cut from each of the four corners of a piece of plastic, art paper

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		or construction paper. Fold corners 2, 4, 6 and 8 into the centre and then pin to the eraser on the end of the pencil.  The students now blow on their pinwheels, holding them near open windows or vents. Take them outside. They should infer the causes of the motion of the pinwheel. The students could look at pictures to observe and point out motion caused by the air. Art: Blow paint pictures using straws. Blow up balloons and tie. Dip string in glue and cover balloon. Let dry and break balloon. Paint finished product. Repeat above activity using paper mache in place of string (globes, puppet heads, planets). Macdonald Starter Series: Wheels

Earth, Space, and Time: Measuring Time

Main Concept: Regularly occuring events can be measured in both non-standard and standard units.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. Certain events occur at regular intervals; others are irregular.	**Students should be able to:** (a) Distinguish between regular and irregular events.	Listen to a tape of regularly and irregularly events. Have students simulate both. Make a drip system and use it to measure time spans. Show the regular beating of the pulse by balancing a piece of drinking straw on the end of a thumb tack and place it on the wrist where the pulse is. Two methods are illustrated.  

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Demonstrate how to find a pulse on one's neck. Let student find their own. Then, pair up to find someone else's. Once you are sure students have found their neck pulse, ask the students at various intervals during the day to find their pulse and count the beats for a specific time. Students can help each other if necessary. Have the students check their pulse before and after an active gym period. Compare and discuss. If possible, startle the class by banging a book, door, etc., and have them check their pulses after this. Discuss any differences between before and after. Discuss similarities and differences; graphs may be made by each student recording his/her pulse during a variety of activities or during a set period of time. Discuss any changes.
2. The passage of time can be measured in non-standard units.	(a) Observe regular events and use them to tell the passage of time.	Make a shadow clock. Stick a pole in the ground and make marks in its shadow at fixed intervals of time. Predict the distance the shadow will move during the next fixed interval. Then use this shadow clock to measure time intervals.
	(b) Estimate the time intervals between regularly occuring events.	Make a sand clock using an egg timer or a funnel in a baby bottle with a marked scale. Before showing a film or filmstrip, have students estimate the length of time that will be spent viewing. These estimates can be recorded and the exact starting time recorded. When finished, record the clock time and see what estimates were closest. If students have outdoor clothing to put on, they can estimate how long it will take them to dress. Groups with similar types of clothing could be established and the time for dressing could be predicted. Make a Candle Clock (teacher demonstration) by marking a candle with centimetre markings. Predict time intervals and burn to check predictions.
3. The passage of time can be measured in standard units: hours, minutes, and seconds.	(a) Recognize the duration of seconds, minutes and hours.	Ask students to suggest ways of determining a second, water dripping, blinking an eye. Have them practice "one hundred and one". Have students suggest events lasting one minute. Try a 33 speed record player. Tape a reference point and count. Make a pendulum that beats 60 times every minute. Measure the duration of events with the pendulum. Macdonald First Library: Time and Clocks. Discuss hour-long activities in which students may be involved, e.g., cubs, swimming, riding the bus, lunch.

Earth, Space, and Time: Measuring Objects and Position

Main Concept: The size and position of an object can be measured by standard and non-standard units. The metric system is a world-wide standard system.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. One object can be used to measure another. It is more satisfactory to use a standard acceptable to all.	**Students should be able to:** (a) Measure a variety of objects, using a basic reference unit.	Have students make paper strips of two pencil lengths and then measure several articles with the strips. Compare results. Discuss the need for standard size of unit. Note: If students have had ample exposure to non-standard units of measurement (math, grade 1 science) only a short review may be necessary.
	(b) Select an appropriate unit to measure small and large objects.	Measure books with paper clips and then erasers; the room with a 30 cm ruler and then a metre stick. Use the unit for measuring.
2. The metric system is a world-wide standard system.	(a) Estimate in the metric system and practice using metres and centimetres appropriately to measure objects.	Using metric tape measures, demonstrates measurement of objects. They can suggest and record estimates before you measure the objects. Discuss partial units. Decide if you want your students to measure to nearest whole or partial unit. Have students select three or four objects the size of which they want to estimate in metres or centimetres. Animate or inanimate objects may be used as well as objects found inside and outside the classroom. Students may make reports on those objects they choose. Cut-out pictures or make drawings can be made. Print the estimate and actual measurement below each. This information can be used for oral comparisons and making graphs once enough data has been accumulated. Note: Students' attention should be drawn to the fact that drawings of small objects should be small in comparison to drawings of larger objects.
3. Objects can be located and measured with respect to a reference object.	(a) Measure the position of an object from a reference point.	Select a reference object. Place another object nearby and have the students measure the distance away and state the direction quantitatively, e.g., 10 cm behind or 4 cm to the right.
	(b) Describe the position of an object relative to a reference point.	Show the students pictures of a lost boat, bicycle or any other object and ask them how they would help find it and tell where it was.
	(c) Demonstrate the six principal directions in space relative to an object (front, back, above, below, right, left).	Have students act out directions with respect to an object.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Play "Guess the Mystery Object". One student secretly picks an object which he/she can see and describes the position of this mystery object with respect to a previously designated reference object. The other students try to guess the object. The winner is then "it". Design an obstacle course. Have one student directing his blindfolded partner using verbal directions only. Art: Make mobiles Language Arts: Antonyms

Properties of Materials: Sand (Grade 2) – Extension Unit

1. Solids (sand) have distinct properties: retain shape; and can be poured only if in small pieces.	(a) Observe and describe two or more properties of sand.	Provide groups of students with trays and sand of different grit sizes. Students can feel, taste, and look at the sand. Spread newspapers or heavy plastic on the floor under the area where students are working.
	(b) Compare sand with different materials of similar size.	Provide students with natural sand, rice, sugar or other materials. Have students compare these materials on the basis of colour, size and texture.
	(c) Observe and describe the behaviour of sand in motion and relate this behaviour to the size of the particles.	Have students sprinkle different sized grit sand from their fingertips. Observe. Let sand flow through a hole in the bottom of a cone cup. Repeat using holes of different sizes. Observe. Drop the sand from different heights. Observe. Slide sand down a tray. Observe.
2. Sand contains particles of different sizes.	(a) Identify the similarities and differences in three different sand types.	Provide groups of students with sand of different grit sizes. Students can examine the sand with a magnifying lens. Students can test whether a cup of coarse sand holds as much water as a cup of fine sand or whether sand dissolves in water.
3. Mixtures containing different sized sand particles can be sorted by using sieves.	(a) Sort sand of different grit sizes.	Provide students with natural sand and sieves of different sizes (colour coded for sorting). A mixture of different grit sizes (coloured) may be used. Sieves can be made of stocking netting or strainers and colour coded by size of opening. Different grit sizes of sand can be coloured by using food colouring.
	(b) Describe an original method for sorting and classifying sand.	Methods for sorting sand which may be suggested by students are: tapping the bottom of a tray; blowing;

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		placing sand gently into water using paint brushes and combs. Discuss which methods worked best. Art: Make sand pictures using coloured sand, glue and construction paper. Make sand paper.
4. A form of sand can be made from larger rocks.	(a) Crush rocks to make a form of sand and compare the size, shape and colour of this sand with natural sand.	Provide students with soft rocks such as limestone bricks, or sandstone. Smaller particles can be made by gently hitting the rocks (placed on a wood board) with a hammer. Caution: Rocks must be placed into a towel or inside several heavy paper bags in order to prevent spattering into the eyes.
5. Sand can be used to measure volume or time intervals.	(a) Measure volume using sand.	Provide groups of students with 4-5 containers of assorted sizes. They should be given the opportunity to discuss how they would use sand to find out which container holds the most. Arrange the containers from largest volume to smallest. Note: Students will have difficulty since they will focus on height as having the greatest volume or may fail to realize that the container should be filled with sand in order to compare volumes.
	(c) Construct timing devices using sand.	Provide students with paper cups or funnels (cardboard) and sand of one grit size. Ask them to time how long it takes the sand to run through the funnels. Have students compare the time required for small sand and large sand to run through their funnels. Provide equal volumes of sand. Note: Teachers should experiment with funnels in order to determine appropriate funnel openings. Students can construct a one-minute timer. They should repeat the activity with their timer in order to see whether the sand consistently takes one minute to run through the funnels.

Grade Three

Stories, Stories

Grade Three

The grade three science program is based on three themes taught in five units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
    Unit 1 Populations
Theme 2 **Change in Matter and Energy**
    Unit 1 Changes in Matter
    Unit 2 Energy, Heat and Temperature
Theme 3 **Earth, Space, and Time**
    Unit 1 Air and Air Pressure
    Unit 2 Sun, Moon and Shadows

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested. A sequenced statement of core concepts and processes is to be found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled ***Process Development*** which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Grade Three

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Populations	3	3	4	Coloured Things	Earthworms Brine Shrimp Starting from Seeds
Changes in Matter	2	3, 2	3	Coloured Things Change Working with Wood Holes, Gaps, and Cavities	Coloured Solutions Mystery Powders
Energy, Heat and Temperature	3, 2	3, 2, 4	3, 4, 5	Science from Toys Metals Change	Ice Cubes
Air and Air Pressure	3		4		
Sun, Moon, and Shadows	3			Early Experiences	Light and Shadows Where is the Moon?
EXTENSION UNIT Properties of Liquids				Holes, Gaps, and Cavities	Drops, Streams, and Containers

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Populations	Oaks, Acorns and Squirrels Vacant Lot Studies Outdoor Fun for Students Sampling Button Populations Differences in Living Things	Ecology in Your Community Pollution Dandelions	D/4 C/3	2	3
Changes in Matter				4	3
Energy, Heat and Temperature	Snow and Ice	Snow and Ice		3	
Air and Air Pressure	Wind			4	2
Sun, Moon and Shadows	Shadows				
EXTENSION UNIT Properties of Liquids					

Grade Three

Interdependency and Interaction among Organisms: Populations

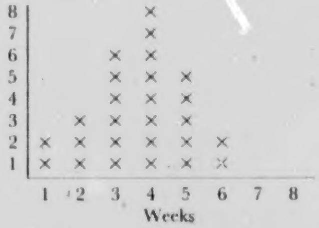
Success of this unit depends on the teacher's planning and beginning growth experiments early.

Main Concept: Populations vary, grown, and develop in different environments.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. The term "population" describes a group of organisms of the same kind in a particular environment.	(a) Define a population.	Initial activity: Examine a picture with a variety of living organisms in their natural environment and have the students give the population count of each, e.g., cow population, tree population. Note: The following studies will be referred to throughout the unit.
	(b) Observe and identify populations in various environments, and classify them as plant or animal.	Have students identify populations in different environments familiar to them. Using each of the identified populations, classify within each environment the animal and plant populations: Populations in a classroom environment. Use terrariums, aquariums, small animals, plants, people. Classify. Distinguish between land and water populations; Populations in a park environment. On a short field trip, observe and identify various populations in the park. Record findings. Sketch or draw things the students have noted. Under the headings of forest, beach, meadow, city street, have students apply their understanding of populations by listing organisms to be found in each area; Populations in a school yard environment. Have groups of students explore small, defined areas in various parts of the school yard to find as many different plant or animal organisms as possible. Record the type found and where it was found, e.g., name of population, place where seen. Demonstrate to students how to tag their finds; Populations in a zoo or farm environment: Observe the less familiar organisms and their environments. Alternatives: Study the life cycle of the meal worm or brineshrimp.
	(c) Observe the growth of a population in a specific environment.	Animal Population. Raise a population of fruit flies. Leave a ripened fruit in a jar for a week or until fruit flies appear;

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		place cheese cloth over the opening; observe the daily changes in the jar and record the findings. As the flies increase in number, have students speculate briefly about reasons for the increase. Mix 1 part water with 3 parts oatmeal and place in a vial. Add a few grains of active dry yeast. Place the vial over an opening in the cheese cloth, covering the jar until four or five flies fall in. Put on the cover. Put small holes in the lid. Close up the hole in the cheese cloth. Have students put their names on the vial. Observe the vial daily for changes in population, food colour, and fly behaviour. Record findings. Note: The fruit fly population is necessary for further study in this unit (4a). Plant Populations: Plant a variety of seeds in a small container, e.g., beans, marigolds, alfalfa sprouts, grass seed. Place on a driptray. Keep a record of each plant population, e.g., date planted, type, number, first seedling, seeds that grew, picture of young plant, leaf tracing. Discuss life cycle.
2. The place where a population normally lives, is its habitat.	(a) Define a habitat.	Discuss the habitat of the fruit fly, meal worm, or brineshrimp. Have students identify the habitat of pets at home or school. Check for their understanding through discussion.
	(b) Match organisms to their habitats.	Cut out or have students draw pictures of animals and pictures of their habitat. Have students use these pictures to match animals with their habitat. Discuss other animals and elicit information about their habitats, e.g., dinosaurs, mountain goats.
3. Populations in a particular habitat form a community.	(a) Observe a community and identify its various populations.	Refer to environments studied at the beginning of this unit.
These populations are interdependent.	(b) Identify the relationships between populations in a community.	Discuss various situations which could happen in a community to interfere with the interdependence of populations, e.g., what would happen if there were no one to care for pets or plants, or if there were no fruit or vegetables. Pond Community: Visit a pond and draw or describe it and the plant life found in it. Collect at least six organisms in a pint jar. Study and record descriptions of organisms. Examine small, microscopic organisms. Keep organisms for a few weeks. Observe changes and discuss.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Supplement studies with filmstrips, books, recordings, etc. (Bird's Hill swamp tour). Discuss interdependence of pond life. Desert Community: If near a dry area, e.g., Carberry, study a desert community. Alternative to above would be a stream community. Contrast pond community with a land community. Study the communities in a vacant lot or a wooded area.
	(c) Observe that populations are affected by environmental stimuli.	Study by means of films, filmstrips or books, the affects of day and night temperature and seasonal change on an animal, plant, or insect community common to Manitoba, e.g., owls, white-tailed deer, crickets, rabbits, blue jay, crocus, oak trees. Refer to "Properties of Living Objects", grade 2, number 3. Research assignments may be done by individuals or groups of students on a particular animal or plant or insect.
	(d) Predict how the removal of one population in a community affects the remaining populations.	Review this section by posing problems for the students to discuss, i.e., how are populations interdependent? What would happen if one or two of the populations were removed from a community? (Begin with obvious populations and the problems their removal would cause, e.g., vegetable population, dairy cows, beef, fish. Then discuss the populations that were studied in this unit). Students in a group could be given a picture of a scene with an environmental problem and asked to discuss it. Join pictures of populations by yarn to show the interdependency of these populations. Discuss how the removal of one of the populations would affect the other populations.
4. Populations are in a state of change. They are affected by environmental factors and other populations.	(a) Measure the size of a population using a sampling technique.	Pencil counts: Ask a student how many pencils are in his/her desk. Based on this information how many pencils would the classroom have altogether? Illustrate the findings establishing a uniform unit of measurement so that the estimates can be visually represented. Have four students repeat the above procedure as a group. Plant grass/wheat/oat seeds in a few square containers. When growth appears, discuss how students can count the plants: Place two straws over containers to form a quadrant; count plants in each quadrant; the students should conclude that since each quadrant contains approximately the same number of plants, the entire plant population could be

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		estimated by counting the plants in one quadrant and multiplying by four. Alternatives: Group students and distribute one loaf of raisin bread. Give each student one slice. Count the number of raisins they can see. Then count the number of slices in the loaf and ask one student how many raisins are in his/her slice. Predict the number of raisins in the whole loaf based on data. Other alternatives may include buttons, eye, or hair colour.
	(b) Observe, record, and predict changes in organisms which have been raised as a classroom population.	In a fruit fly culture one week old, have students observe the larvae. The second week, have students watch the populations increase and see the need for food refills. Record changes in the life cycle. Predict how many flies there will be by the fourth week. Note: Start more than one fruit fly population in case one does not develop. Make a fruit fly histogram over a period of six weeks. Count the fruit flies by laying the glass vial containing the fruit flies on the overhead projector and projecting the image on a sampling grid drawn on the chalkboard. The record should show a population increase and decline. Discontinue the food supply. Observe the life cycle of planted bean seeds. From the bean pods produced, predict how many new plants could be grown. Take a picture of bean pods grown. Histogram: A graph of a frequency distribution in which rectangles with bases on the horizontal axis are given widths equal to the class intervals, and heights equal to the corresponding frequencies. 
	(c) Infer causes of population descrease.	List habitat factors which cause change, e.g., sunlight, air, water, food, space, pollution, soil. Check off factors which are necessary for the survival of the fruit fly, beans, cats, people, frogs. Which factors are common to all listed? Using a fruit fly histogram and records, discuss why the population decreased. This objective should be introduced but students may not be able to go beyond their personal experiences. Answers may not pertain to the factors that are listed.

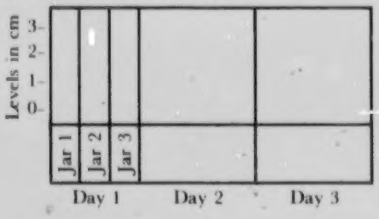
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(d) Infer that colour is important for an animal's survival.	On one card, paint a brightly coloured worm, slug, and ant. On a second card, show the actual colouring. Discuss which could be seen most readily and which colouring would therefore be best for the animal.
	(e) Graph the number of objects found in a specific area in a given amount of time.	Mark off a square metre of grass. Drop ten white toothpicks over your shoulder. Use a set time period (1 min.) and have students pick them up. Repeat the above activity using three or four different colours, one of which should be green. Discuss the results. Hold a scavenger hunt. Discuss data from the graph and have students colour some object such as a rock so that it can be camouflaged in a habitat. Then place the coloured objects in the habitat and ask students to try to find them.
	(f) Discuss possible causes for human population problems.	Activity: Collect pictures of people in a variety of environments, i.e., after earthquakes, in drought areas, crowded cities, etc. Discuss and predict what will happen to the future populations and why.
	(g) Discuss man's ability to endanger a population or to cause it to become extinct. (Values development).	Have students do group projects on the blue whale, passenger pigeon, buffalo, whooping crane, or trees to find out how man has affected these populations. Share the reports. Have a round table discussion of other ways in which man can endanger populations and how he can prevent this from happening. Social Studies: Eskimo, Indian populations.
5. The existence and behaviour of living organisms affect the well-being of mankind and/or the overall life in a community.	(a) Discuss the effects organisms can have on a community or mankind.	Review the interdependence of populations. Discuss alterations which may occur in the behaviour of living organisms and which may affect mankind and/or the overall life in the community, e.g., over population, elimination of suitable habitats, pollution.
	(b) Communicate and infer that organisms can be labelled helpful or harmful depending upon one's viewpoint or values.	Activity: ***What do you think?*** Locate pictures which show such organisms as a dragon fly and a mosquito, a bird eating corn, a dandelion and a slug, a deer eating tree bark. Discuss if the organism is being helpful or harmful to man. Bring out the idea that an organism can be both helpful and harmful, e.g., bird eating corn—harmful; bird eating insect—helpful. Note: In a discussion with students, a right answer must not be pressed for. As the activity objective states, the label is dependent on personal values or viewpoints. Ask students to present their own research done on an organism and the label they would assign the organism. Double labels may occur.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Take a walk in your area to see where man has been helpful or harmful to a community, e.g., man-made structures discouraging animal and plant populations. Chart ideas. Expand the discussion by providing other examples such as cutting down trees or filling in water holes. Group projects could be planned to improve a particular area for plants and animals.

Changes in Matter and Energy: Changes in Matter

Main Concept: Matter is made of particles which are too small to be seen.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Review properties of matter from grades one and two.		
2. Matter occupies space.	(a) Observe that two objects cannot occupy the same space at the same time.	A book can be placed on a desk and students asked whether they can place another book in the same spot without moving the first book. What happens when we try to place two solid objects in the same place, e.g., two cars? Other examples can be discussed.
	(b) Observe that a liquid takes up space and takes the shape of the container into which it is poured.	Provide three or four labelled jars, two of which are equal in volume but of different heights, and a container of water for each group of students. The groups are to discover which jar holds the greatest volume of water. One method is to use one of the jars as a standard unit. Take one standard unit jarful of water out of the container at a time and mark each water level on the container with masking tape. Records should be kept.
	(c) Observe that solids will occupy space in liquids.	Provide narrow jars, water, and marbles. Partially fill the jars with water. Ask the students to predict the effect of adding marbles to the water. The effect of adding three marbles to the level of the water can be measured.
	(d) Record data in graphical form.	Marbles can be added in groups of three and the levels of the water compared to the number of marbles. Compare on a graph. Math: Discuss liquid measurement in the metric system (litres, ml).

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(e) Predict the effect of adding insoluble solids to liquids.	Students can be asked to predict the effect of adding more marbles to the water. The effect of other solids on liquids can also be examined.
3. Matter is made of small parts.	(a) Observe the similarities between the properties of large and small parts of an object.	Chalk and sugar cubes can be broken into pieces as small as possible by using a spoon and paper towelling. Pieces can be examined with a hand magnifying lens and observations recorded. Other objects which can be examined are newspaper photographs, crushed spaghetti, and sand. Blackboard erasers can be clapped together in a beam of sunlight as an alternative activity.
4. Particles can distribute themselves throughout a liquid.	(a) Identify and infer the presence of sugar in a solution of sugar and water.	Make a sugar solution which has a detectable sweet taste. Students are asked to identify the substance in the liquid. Discuss with students that this tasting is an exception to normal procedure. Caution: Students should be warned not to taste any substances at any time unless they have been told it is safe to do so.
	(b) Compare the properties of a solution after filtration with the properties of the original solution.	A solution of salt and water is poured through a paper towel into a container. How will the filtered liquid taste? Art: Grow crystals in a coloured sugar solution. Later these can be used to make necklaces or bracelets.
	(c) Infer that solids, when dissolved, have the ability to pass through small openings in towelling.	The filtered salt solution can be allowed to evaporate and the remaining crystals examined with a magnifying lens. Use a taste test on safe crystals.
5. Particles can distribute themselves throughout a gas.	(a) Observe the formation of condensation and infer the presence of water vapour in the air.	Ice cubes can be placed into a metal lid over the top of a container of warm water. The activity can be repeated in different parts of the room or outside.
	(b) Test the effect of different temperatures on the rate of evaporation. Identify variables that affect the rate of evaporation. Over a period of time, measure the water levels and record the measurements on a graph.	Several jars of the same size are filled with water and placed in different places in the room (e.g., over the radiator, on a shelf, refrigerator) at the same heights. Mark the level of water. Measure, graph, and compare the water level each day. Ask students to suggest other variables they they could test (e.g., narrow and wide-mouthed jars with equal amounts of water, paper strip in water and no paper strip). Macdonald Starter Science: Wet and Dry. 

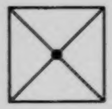
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(c) Observe and infer the presence, by smell, of a substance which passes through a membrane.	A rubber band with a drop of perfume or artificial flavouring on it can be placed into jars. Students identify the odour. Ask a student to go outside the room and then have a perfumed jar placed in a corner of the room. Ask the student to locate the odour. How did the student do it? Social Studies: Construct a bulletin board to illustrate the effectiveness of each material as a filter. Which material would you use at home? Why?
	(d) Test the ability of various filters to prevent an odour from escaping.	Test different kinds of towelling, waxed paper, filter, and writing paper. Students can suggest other ways to prevent an odour from coming through a filter, e.g., doubling the paper. The effectiveness of each filter could be tested using different materials, e.g., moth balls and perfume, moth balls and candy.
6. Small particles can be used to build larger pieces of matter.	(a) Observe that small particles can be used to form larger pieces of matter.	Stir a spoonful of Epsom salts or table salts into a saucer of water until dissolved. Let the solution evaporate overnight or until crystals are formed. Have students observe Epsom salts or table salt under a hand lens. Caution: Students should be warned not to taste any substances at any time unless they have been told that it is safe to do so. Magic Garden: Place some coal, charcoal, or a sponge in a bowl. Mix a solution of ¼ cup of water, 1 tablespoon ammonia, ¼ cup table salt, ¼ cup laundry bluing. Pour the solution over the coal or charcoal in the bowl. Spread the thick slurry of salt evenly over the charcoal or coal. A little food colouring or dye placed here and there on the charcoal or coal will add colour to the growing crystals. Interesting effects may also be achieved if dyed toothpicks are inserted into the charcoal.
7. Mixtures of materials can be separated on the basis of unique properties. Mixtures of different solids may be separated by a variety of methods on the basis of the unique properties.	(a) Identify solids that float or sink in water.	Students can be provided with a rubber band, pencil, paper clip, plastic button, popsicle stick or similar materials. Experiment to see which ones float in water.
	(b) Classify solids according to their attraction by magnets.	Chalk, tacks, pencils, toothpicks, washers, erasers or other materials can be tested and recorded according to their attraction to magnets.
	(c) Predict the ability of magnets to attract solids.	Use objects made of different materials including different metals (penny, steel nail, aluminum nail, large paper clip, copper tack). A chart can be provided to make predictions. Fill in the Chart

Object	Attracted	Not Attracted

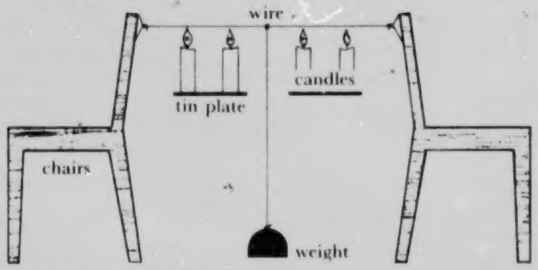
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(d) Separate mixtures of solids on the basis of their properties.	Mixtures of wood chips and sand, sand and iron filings, sugar and rice, gravel and sand can be placed at different work stations. Have ready a container of water, a wire strainer and a magnet. Groups of students attempt to solve the problem of separating a mixture. Methods of separation other than straining, floating, or using a magnet may be suggested by the groups.
8. Mixtures of certain solids and liquids can be separated by a variety of methods such as filtration and sedimentation.	(a) Observe and compare filtered mixtures of solids and liquids.	Mixtures of solids which dissolve in water (salt, baking soda, or water colouring paints) and solids which do not dissolve easily (cocoa, starch, or flour) are all filtered through paper towels. Record and discuss observations of the filtered liquids and any residues.
	(b) identify solids which dissolve readily in water to form a solution and cannot be separated from the water by filtration; identify solids which do not dissolve readily and can be filtered out.	
	(c) Test different filters used to separate solid–liquid mixtures.	Make predictions about the best filters for the above materials, e.g., paper towel, tissue paper, various kinds of cloth, nylon stocking. Perform the operations using samples of coarse and fine filters. Record and compare results. This can be related to filtering systems for water purification.
	(d) Classify mixtures of water and solids as solutions or suspensions, and record changes over time.	Provide small quantities (a teaspoonful) of starch, baking soda, salt, plaster of paris, and sugar. Each material is mixed with 250 ml of water. The results are recorded after five minutes, fifteen minutes, and on the next day. Through discussion, obtain the students' guesses about the materials. Then let them know what the materials are. Label the materials. Other materials such as powdered milk, powdered drink mix, instant tea, or other materials may be brought from home and tested. Art: Have students cup their hands together. Fill them with plaster of paris and hold it until it has hardened. Paint the seashell that was formed. Note: Possibility of allergic reactions to plaster of paris. Suspension: The condition of a solid distributed in very fine particles throughout a fluid. Solution: A preparation made by dissolving a solid, liquid or gaseous substance in another substance, usually a liquid.
9. Dissolving a solid in a liquid is a physical change.	(a) From the fact that the physical properties of the solid are retained, observe that dissolving is a physical change.	Students record the amount of a teaspoonful of salt by volume or weight. Dissolve the salt in water. Let the solution evaporate and record the amount of solid remaining.

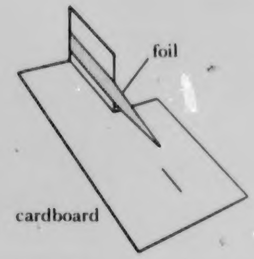
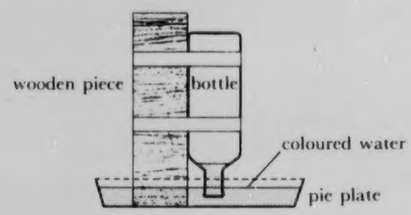
Changes in Matter and Energy: Energy, Heat and Temperature

Main Concept: Heat is a form of energy. Heat can produce changes in the properties of matter.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. Work is done when an object (matter) moves as a result of a push or pull.	**Students should be able to:** (a) Identify the interaction between two objects.	Teachers: You may find it beneficial to have taught the unit "Changes in Matter" before this unit. Use before and after pictures which indicate motion, e.g., nail hammered into wood, a bicycle moving, or a review of student's actions in moving desks, pencils, and other objects in order to identify work situations. Evidence of situations where work is not being done, e.g., book on a table can be identified. Physical Education: Push and pull activities for the gym. Do push ups, moving the body by pushing or pulling.
	(b) Infer that work is being done when two objects interact and produce motion.	Make a pinwheel from a 12–15 cm paper square. Cut diagonal lines to about 2 cm from the centre, curve the corners into the centre, push a pin into an eraser. The ability of air or water (if the wheel is of heavy cardboard) can be used to develop the concept of interaction and work. Art: Simple mobiles.
2. Energy can produce motion and do work.	(a) Observe situations where energy does work.	Large and small objects such as books of various sizes can be used. Students attempt to push the books using one finger.
	(b) Observe the effects of variables which will change the motion of an object. Examples are height, mass, surface made of different materials.	Drop a ball (rubber, tennis, golf) from different heights. Measure and record on a histogram the heights to which the ball bounces. Investigate and compare the effects of other variables (mass, matter) when the height remains constant. For example, drop the ball from the same height onto different surfaces. Discuss observations. Histogram: A graph of a frequency distribution in which rectangles with bases on the horizontal axis are given widths equal to the class intervals and heights equal to the corresponding frequencies. Note: Students may only be able to distinguish significant differences. Staple a rubber band to a piece of cardboard and shoot a ball of crumpled paper from the band. Record the distances the ball is moved and compare to the distance the band is pulled. Three or four trials for each distance the rubber band is pulled back should be recorded. 

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Other variables such as different thicknesses of rubber bands or different lengths of bands may be experimented with. Record observations. Pulling the band back from the left or the right side can be compared to those observations made when the centre of the band was used, as long as the same distances are maintained.
3. There are different forms of energy.	(a) Observe different kinds of energy and the interactions which have produced motion.	Take a walk in the school and note different kinds of energy in operation. Note also the resulting motion, e.g., telephone, typewriter, gym class, walking, heating system, washroom, store, taps. Take a walk outside to see if different kinds of energy can be found in comparison to those found within the school. Discuss the examples found from each exploration. The middle of a pencil can be twisted four to six times in the loop of a rubber band and released to show students one simple form of energy and the motion which is produced.
Heat is one form of energy.	(b) Identify heat as a form of energy.	Make spirals out of thin pieces of paper. The spiral is balanced on a pencil point. Find a place in the room where the spiral moves, e.g., near a warm air souce. A heavy spiral can be made out of aluminum foil and placed over an incandescent lamp or radiator. Caution: Supervise carefully if using a hot plate or similar device. Other examples can be discussed, e.g., kettle. Students should be aware of heat as a form of energy but may deal with the idea very simplistically. The concept is so common that drawing the idea from the students may seem difficult. *Extension:* Studies may be undertaken concerning the energy crisis in North America. Studies may also include areas which are being explored to provide new sources of energy from heat (solar energy). Through discussion obtain a working definition in the students own words for temperature. Students may wish to devise definitions after activities.
4. Temperature is the degree of hotness or coldness of an object.	(a) Observe that differences in hot and cold can be determined by the skin; infer that the skin is not a reliable instrument to measure hot and cold.	Fill three cups with water at different temperatures (warm, room temperature, cold). Students place one finger into the cold water and a finger from the other hand into the warm water. Then reverse the positions of the hands. The warm and cold water should be identified in each case. After holding a finger from each hand in the hot and cold water con-

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		tainers, the student alternately dips his fingers into the container with water at room temperature. Fingers should indicate different degrees of warmness for the water at room temperature.
5. Matter tends to expand when heat is added (warmed) and contract when heat is removed (cooled).		Dip the opening of a narrow can into liquid soap so that a thin film covers the opening. One student can hold the can and observe the effect on the film. Note that the heat from student's hands causes the bubble to expand.
Solids expand or contract.	(a) Observe that solids expand when heat is applied and contract when heat is removed.	Fasten a bare copper wire between two chairs. Attach a weight at the centre of the wire, close to but not touching the floor. Swing the weight and heat the wire. Note: The source of heat should be sufficient (4-5 candles) to ensure the experiment works. Observe the distance of the weight from the floor.  If possible, obtain a ball and ring. Demonstrate to the students that the ball can be pushed through the ring. Heat the ball by immersing it in boiling water for a few minutes. Try to fit it through the ring. Discuss observations. Allow the ball to cool and demonstrate that it can pass through the ring. Immerse the ring in a pan of ice water for a few minutes. Try to pass the ball through the ring. Discuss observations.
Different solids expand different amounts.	(b) Compare the expansion of two solids and infer that solids expand different amounts.	Repeat the above experiment using different wires such as picture and aluminum wire of the same thickness. Note: The teacher should find those wires which will best show expansion.
	Predict the effect of heat on objects.	Use pictures or actual examples of heat effects and ask students to predict the change, e.g., placing a stuck jam jar lid (metal) under hot water, the effects of temperature upon the space at the end of bridges and steel rails in the summer and winter.
	Investigate the variables that affect a solid thermometer.	Make a thermometer using thick aluminum foil bonded to paper, a small piece of cardboard and clear tape. The strip

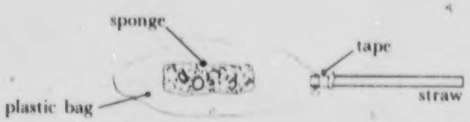
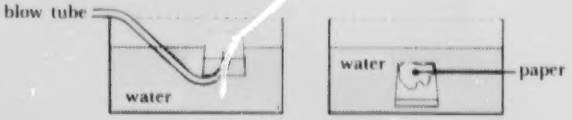
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		of foil must be cut to form a point at one end. The piece of cardboard should have a tab cut and folded, to which the foil pointer will be taped. Note: The pointer moves because the foil bonded to the paper expands when heated. The foil bonded to the paper contracts more than the paper when cooled. The foil pointer should not touch the part of the cardboard which is lying flat. Make sure the pointer is straight. Look down on the pointer and mark a line on the cardboard under the end of pointer. Place the thermometer in different locations in the room. Observe the instrument at various times during the day. Discuss the students' observations. 
	Predict and investigate variables that may affect a solid thermometer.	Discuss the effects that the size or shape of the pointer may have on the thermometer. Place different coloured construction paper under the pointer and place it in the sun for five minutes.
Gases expand when heat is added and contract when heat is removed. Temperature can be measured by a thermometer in which gas expands or contracts.	(c) Infer that heat gain causes expansion and loss of heat causes contraction in a gas.	Assemble a narrow necked bottle, coloured water in a pie plate, and a piece of wood or other heavy object. Warm the bottle in direct sunlight and insert upside down into the coloured water in the pie plate which has been placed in a cool spot. Attach the heavy object to the bottle with masking tape. Note: When the warm bottle cools, the coloured liquid rises up the neck of the bottle. 

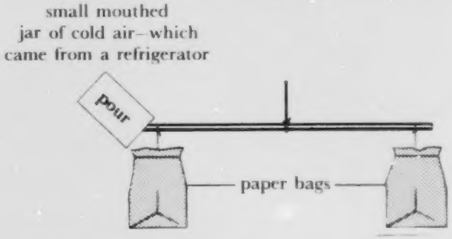
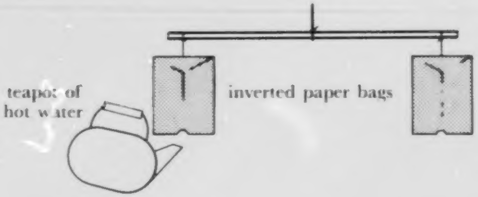
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Make an air thermometer: Place a strip of tape on the neck of the bottle used in the previous activity; place the apparatus in a sunny area and then in a cold area (e.g., refrigerator) for about a half hour; mark the level of liquid when it stops moving in both the hot and cold areas; make a scale between the hot and cold markings. Use the air thermometer to check temperatures in the morning, noon, etc. Expansion: to increase in extent, size or volume. Contraction: to become drawn together or reduced, become smaller.
Liquids expand and contract when heat is added and removed. Temperatue can be measured by a thermometer in which a liquid expands or contracts.	(d) Infer that heat causes expansion and removal of heat causes contraction in a liquid.	Construct a water thermometer: fill a large jar with coloured water; attach the lid and insert a small plastic straw through a small opening in it; firmly secure the straw with plasticine to the lid; put a drop of oil in the straw so that the oil floats on top of the water (this will prevent evaporation of water); attach a piece of cardboard to the straw so that variations in the height of the water can be recorded; place the water thermometer in the refrigerator and in a warm area of the room. Discuss results. Alternative: Fill two identical bottles to the same level in the necks, one with water and the other with rubbing alcohol. Place in the refrigerator for a half hour. Measure and compare the heights of the liquids in the two bottles. Then place in sunlight and repeat the measurements.
Different liquids expand different amounts.	(e) Observe the expansion of two liquids and infer that different liquids expand different amounts.	Construct a second liquid thermometer using a liquid other than water (duplicating liquid). Repeat procedure as in (d) and compare results.
6. Temperature is a measure of the warmth or coldness of an object or substance with reference to some standard value.	(a) Investigate the variables that affect a thermometer (e.g., where heat is applied to the thermometer, temperature).	Use uncalibrated thermometers and rulers or regular thermometers that have the scales covered with masking tape. Investigate the most sensitive parts of the thermometer by touching different areas of the thermometer. Note: Do not use clinical or calendar thermometers as they are not designed to measure extreme termperatures. Put the thermometer in ice water and mark with a felt pen when the liquid has finished moving. Using boiling water, mark the level to which the liquid rises inside the thermometer. Other groups of students can be working with other calibrations, e.g., the rise of the liquid when placed near a heat register; near the window, in a sunny exposure; near the refrigerator. Record temperatures using calibrated thermometers. Doing these activities with calibrated thermometers will give the students practice in reading the thermometers. Caution: Do this activity with only a small group of students at a time. Close supervision is necessary for the safety of students.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		If an outdoor thermometer is available and can be located at a site accessible to the students, a temperature chart could be kept for a week or month. Note: The volume of water used to prepare ice will affect the length of time for melting at 20 C. water — time (approximate) 10 cc — 60-70 min. 15 cc — 75-85 min. 20 cc — 90-100 min. 25 cc — 100-110 min. 30 cc — 105-115 min. Control Cube: Will give a rate of melting which serves as the basis for comparison to determine whether the materials used in the activity increased or decreased the melting rate of an ice cube.
7. Heat passes through some materials easily (conductors). Other materials do not conduct heat easily (insulators).	(a) Compare the insulating and conducting qualities of materials; infer that materials vary in their ability to conduct heat.	Place ice cubes of the same size on various surfaces, e.g., tin foil, paper towelling, metal object, newspaper, styrofoam meat trays, wood. Keep a control cube in a cup. Record the starting time. Record the length of time it took to melt the ice cube.
	(b) Observe that the melting rate of an ice cube can be altered by changing its form, applying heat, and using conductors or insulators.	Ice Cube Race: Who can get an ice cube to melt the fastest? Set off-limit areas in the classroom and limits on the materials used. Provide students with materials which are insulators and conductors as well as with a hammer, water, plastic or glass containers. Distribute cubes. Allow students to experiment with this activity more than once. Have the students whose cubes melted the fastest explain what they did.
	(c) Predict the effect materials will have on the melting rate of an ice cube. Test this prediction be designing an ice cube keeper.	Review with the students the ways they have found to make ice melt faster. Can they do the opposite? Provide the same material as in Activity (b). Distribute the cubes. Allow the students to experiment with this activity more than once.
	Extension: (d) Hypothesize that the melting rate of an ice cube is affected by the amount of material around the ice cube.	Repeat the above activity. Wrap an ice cube in one layer of material. Record the melting time required. Then increase the number of layers around the ice cube using the same material. Record times. Compare the melting times with the number of layers of the material used.

Earth, Space, and Time: Air and Air Pressure

Main Concept: Air is a form of matter which has special properties.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Air occupies space.	(a) Infer the presence of air by the resistance it offers. (Some of these activities reinforce concepts and processes taught in the section, "Properties of Matter", grade 2).	Fill a plastic bag with air, tie it, and then squeeze. Make a Puffing Machine and observe the behaviour of the plastic bag when the sponge is squeezed. Then place the end of a straw in a pan of water, squeeze the sponge, and observe. Later attach the other plastic bag to the straw and move air into this bag by squeezing the sponge.  Art: Use Puffing Machine in straw blowing art. Put a blob of paint on a piece of paper and use the puffing machine to move this paint over the paper. See what type of designs the students can make. Drop a piece of cardboard from shoulder height to the floor. The first time, hold it horizontally and the second time, vertically. Note the difference in the rate of fall due to air resistance.
	(b) Infer the presence of air by its displacement of water.	Put a glass into a container of water. Blow air into it through a tube. Show students a way to put a paper towel under water and not get it wet: Crumble the paper towel in the bottom of a glass; hold the glass upside down and push it down into a basin of water. Do the same with floating ball. 
2. Air exerts pressure.	(a) Observe the effects of air pressure counteracting other forces.	Do a demonstration of the crushed can experiment: put a small amount of water in an empty can (e.g., duplicating

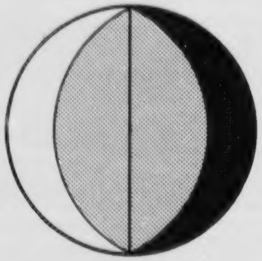
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		fluid can); heat until steam comes out; remove from heat; seal tightly. Observe. Stand a pumber's plunger on the table. Put scraps of paper around the edge. Push down hard on the plunger and observe movement of the paper. Try to lift the plunger. Make a small hole in a second plunger and repeat the experiment. Observe. Seal the hole and repeat. Fill a large plastic garbage bag with air. Seal. Allow students to sit on it. Immerse a straw in water. Put index fingers over the top and bottom of the straw to lift it from the water. Keep fingers on top and remove finger from bottom. What happens? Why? Fill a glass with water. Place an index card over opening. Invert over sink. What happens? Why? Discuss real-life applications, e.g., car lifts in garage, air mattresses, bubble dome buildings. Place a balloon or a plastic bag under a book and gradually blow the balloon up.
3. Warm air rises and cold air sinks.	(a) Observe that warm air rises and cold air sinks.	Make a bag balance for weighing cold air.  small mouthed jar of cold air– which came from a refrigerator pour paper bags Physical Education: Have students move about an area using heavy steps (cold air) then using light steps (warm air). Also move in high levels and low levels. Make a bag balance for weighing warm air. 

Earth, Space, and Time: Sun, Moon and Shadows

Main Concept: The structure of an object affects the transmission of light through it. The measurement of time and the structure of an object can be determined from the shadows cast by an object.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. A shadow results when an object blocks the passage of light.	(a) Observe the elements necessary to produce a shadow.	Using a strong light (200 watt bulb or filmstrip projector), place objects in front of the beam, producing clear shadows on the wall. Try making shadows with hands. Do playground shadow games. Make silhouettes of each student.
	(b) Infer the shape of an object by looking at its shadow.	Try to guess the type of object on the basis of the shadows produced.
	(c) Distinguish among opaque, translucent, and transparent, and observe the resulting type of shadow.	Hold various materials (opaque, translucent and transparent) before a light and observe the effect (e.g., book, coloured plastic object, a piece of glass). Language Arts: Dramatics with shadows (integration).
2. A light source which causes a shadow to be cast is always located in the opposite direction of the shadow.	(a) Predict the direction a shadow will fall when a light source is placed in various positions.	Hold a light source (flashlight, lamp) with respect to the objects and predict the different positions of the shadows. Check predictions.
3. Multiple light sources produce multiple shadows.	(a) Infer the number of light sources by observing the number of shadows.	Set up a pencil vertically on a wad of plasticine. Cast a shadow with a flashlight, then with several flashlights.
4. The size of the light source determines the type of shadow.	(a) Observe that the size of the light source affects the type of shadow produced.	Set up a pencil as above and shine the flashlight bulb on it. Note the shadow. Then cover the bulb with a paper cup. Note the difference.
5. The size, shape, and sharpness of the shadow is dependent upon the relative positions of the object, the light source, and the receiving surface.	(a) Observe that the size, shape and sharpness of a shadow vary with the relative positions of the light, object, and screen.	Manipulate several objects and cast shadows with them: ruler, ball, paper towel roll, cube, scotch tape roll.
6. Objects can be seen only if they produce their own light or reflect light.	(a) Infer the presence of light if an object is seen.	Construct a peep-box: Place a small hole in one end of a shoe box; look into the box; then put a variety of objects into the box (these should include black objects, balls of foil and coloured objects). Can they be seen? Put a flashlight that has been turned on into the box. Can it be seen? Discuss the results.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
7. Some surfaces reflect light better than others.	(a) Observe and compare two different reflecting surfaces.	In a darkened room, hold a mirror facing a flashlight beam. Then let the flashlight shine directly on the wall. Observe. Repeat this investigation using crinkled aluminum foil instead of the mirror. Repeat this investigation again using a non-reflecting object such as a book.
8. Sunlight can be blocked by clouds and by objects which form shadows on the earth.	(a) Observe the shadows caused by clouds.	Go outside on a day when there are fluffy cumulus clouds and observe the shadows made by them. Simulate this in the classroom with a lamp and paper or cotton clouds.
	(b) Observe the shadows caused by objects.	Go outside on a sunny day and observe the shadows made by trees, different sized buildings, cars, bicycles, or whatever may be available. Various sized objects could also be taken from the room and placed on the ground to observe shadows.
	(c) Infer the location of the sun by observing shadows.	Make a shadow clock: Find a pole or place a stick in the ground and observe the movement of the shadows; mark the shadow of the pole at regular times. Use this clock to measure the time duration of regular classroom events. Show pictures of hand-drawn or cut out shadows to the class. Have the students indicate the position of the sun for each picture by pointing or moving to that position. Art: Have students draw the same scene in the morning and then before they leave school, showing shadows of objects and the position of the sun.
9. A given point on the surface of the earth moves out of the sun's light into the earth's shadow as the earth rotates. This causes night. A given point on the surface of the earth moves out of the earth's shadows and into the sun's light as the earth rotates. This causes day.	(a) Simulate the sun–earth relationships.	Darken the room and set up an electric light for the sun and a ball for the earth. Observe the shadow on the earth. Rotate the earth and observe how a given point on the earth moves into and out of the shadow. Discuss day and night with respect to sunlight and shadows. Note that day and night are regular events.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
Extension:		
10. From a given point on the earth's surface, the moon seems to appear in the east, move across the sky, and disappear in the west because the angle of its reflected light changes as the earth rotates.	(a) Observe that the moon appears to move across the sky.	Set up a moon watch. Observe the moon at regular intervals and discuss its changing positions.
	(b) Measure the position and chart the path of the moon.	Observe the moon and measure its position at regular intervals. Beginning at the horizon, place fist upon fist to determine how many fists above the horizon the moon is. (It takes approximately nine fists to go from the horizon straight up). Provide the student with a work sheet on which to record the position of the moon at various observation times.
11. The moon appears to change shape during the month because of its position in relation to the earth's shadow.	(a) Observe and record the phases of the moon.	Observe the moon once a week for one month and draw a picture of each observation. 
Extension Unit—Properties of Liquids **Main Concept:** Liquids have characteristic properties. Variation in the properties of different liquids may be used to classify liquids.		
1. Liquids vary in such specific properties as the shape of their drops, their mass, and their mixing qualities.	(a) Identify and describe the properties (e.g., shape and size) of water drops on a specific surface (waxed paper).	Provide groups of students with medicine droppers, small jars of water, soda straws, and wax paper. Initially students should develop skills in making small and large drops. Test the effect of hole size on the size of drops. Examine and describe (draw) the shapes of drops. Make large drops out of two or three small drops. Are there differences between large and small drops?

<table>
<tr><th>Organizational Framework for Teachers</th><th>Objectives</th><th>Suggested Activities/Teacher Notes and Integration</th></tr>
<tr><td></td><td></td><td>Discuss similarities between different large and small drops. Use the straw to move drops and to blow on drops. Observations should be recorded. Sizes, shapes, thicknesses and edges of drops can be viewed through a magnifying lens. Describe and record.</td></tr>
<tr><td></td><td>(b) Compare the behaviour of water drops on two different surfaces.</td><td>Provide students with small construction paper cards and aluminum foil or plastic. Examine the shape of small and large drops, ease of moving drops and ease of making large drops on these two srufaces.
Additional activity: Provide white paper, crayons, salad oil, and chalk. Have students fold paper into four sections. Colour one section with crayon, one with chalk, and one with oil. One section remains white. Drop water on each section. Examine the nature of the drops in each section. Compare drops and record.</td></tr>
<tr><td></td><td>(c) Compare the shapes of different liquids on a specific surface.</td><td>Compare similar sized drops of different liquids on waxed paper. Students compare and describe (draw) the drops of different liquids. Cooking oil, vinegar, syrup, and water are possible liquids.
Alternate activity: Fill two equal sized, paper cups or plastic vials, one with water and the other with oil. Use eye-droppers to fill cups to overflowing. Compare the shapes of the tops of the liquids and determine which container seems to hold the most liquid.
Art: Make drop pictures by using different coloured liquids on surfaces held vertically or horizontally. Make copies by pressing a sheet carefully on the picture. What is the effect?</td></tr>
<tr><td></td><td>(d) Infer the identity of mystery drops from observed properties.</td><td>Provide students with containers of mystery liquids (water, baby oil, vinegar) and materials with different surfaces (e.g., wax paper, aluminum foil). Put a drop of each liquid on each surface. Help students chart observations.
<table>
<tr><th></th><th>Waxed Paper</th><th>Clear Paper</th></tr>
<tr><td>Liquid A</td><td></td><td></td></tr>
<tr><td>Liquid B</td><td></td><td></td></tr>
</table></td></tr>
<tr><td></td><td>(e) Observe and describe the mixing of liquids.</td><td>Provide groups of students with a plastic vial and containers of oil (salad, baby) and water. The two liquids</td></tr>
</table>

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		should be placed into the vial. Does it make any difference if the order in which the liquids are placed into the vial is different? What is the effect of shaking the vial and then letting the vial stand. Ask students to predict which liquids will float and which will sink. The teacher can test the predictions by asking students what a fair test is and demonstrating the test.
2. Water drops will magnify objects.	(a) Construct a water drop magnifier.	Have students examine grainy pieces of wood, letters on a newspaper, the desk top, and other objects through water drops. Compare the effect of small and large drops. Students may wish to compare the shape of water drop magnifiers to magnifying lenses.

Grade Four

Grade Four

The grade four program is based on three themes which are taught in five units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
    Unit 1 Population Interaction
Theme 2 **Changes in Matter and Energy**
    Unit 1 Electricity
    Unit 2 Sound
    Unit 3 Structures and Forces
Theme 3 **Earth, Space, and Time**
    Unit 1 Water and the Land

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested.

A sequence statement of core concepts and processes is found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled *Process Development* which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Grade Four

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Population Interaction	5	4	4,5	Minibeasts Tackling Problems Part 1	Animal Activity Earthworms Behaviour of Mealworms
Electricity	4	4	5	Early Experiences Science from Toys Metals Using the Environment	Batteries and Bulbs
Sound	4	4	4	Early Explorations Early Experiences Working with Wood	The Musical Instrument Recipe Book Whistles and Strings
Structures and Forces		4	4	Structures and Forces	Senior Balancing Structures Bones
Water and Land	4	2	4	Holes, Gaps and Cavities Investigations Part 2	Kitchen Physics Water Flow Sink or Float Stream Tables Clay Boats

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	SCIENCE IN ACTION	SPIES	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Population Interaction		Ecology in Your Community	D (Earthworm)	Studying Birds Studying Insects Studying Mammals Studying Plants			
Electricity						5	4
Sound		Your Senses Pollution	C (Sound Off)		Light and Sound	3	
Structures and Forces		Running Water		Studying Soil		5	
Water and Land				Studying Soil		5,3	4

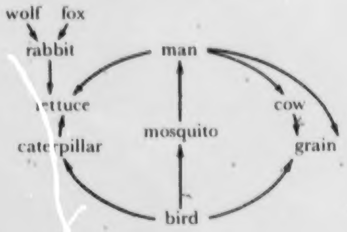
Interdependency and Interaction among Organisms: Population Interaction

Main Concept: Interaction occurs within and amongst populations.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Organisms interact within a population	(a) Observe and describe interactions necessary for animals to build their homes.	Observe a beehive (an old one, one in use, in a film, a picture). Discuss how the bees interact to build the hive. Have students discuss how other animals cooperatively build their homes, i.e., birds, beavers, wasps, man. Discuss how each population interacts within itself. Students could be put into groups with each group researching a particular animal. Models could be made of the habitats, research booklets compiled, and class presentation made. Reinforce by discussing how all populations interact to make homes. Make an ant colony to observe home building. Place a small jar with some sugar or oatmeal in a larger jar. Fill the gap between the jars with dry soil or sand. Place a few ants in the small jar. Cover the large opening with cheesecloth. Observe over a period of days. Record date begun, observe every few days, and make a diagram of the developed colony. Discuss interactions within the colony. Make an earthworm farm. Observe and record interactions. Raise a family of mammals such as mice, hamsters, rats. Design experiments to determine the types of homes preferred. Record observations of interactions. Match pictures of various animals to the pictures of their homes. Films: Ants, Beaver, Beaver Dam. Art: Collages of homes of various organisms. Make a 3-D beaver habitat using paper mache and twigs. Maze for rats, mice, or hamsters.
	(b) Infer ways in which various animals care for their young.	Discuss ways in which animals care for their young. (Provide pictures of various animals and their young). Have students describe what happen if the young are not cared for. Chart the suggestions from the discussion. Observe and record interactions of any classroom populations. Identify independent animals, i.e., young that do not need adult supervision, e.g., worms, frogs.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Based on whether or not young need care, classify animals as being dependent or independent. (Research project). List interactions of children with parents. (Extend to consider ways in which all humans are dependent). Art: Frogs, turtles or worms from egg cartons or paper plates. Poetry: Good opportunity for limericks.
2. Populations of animals depend on other populations for food.	Classify organisms as plant eaters (herbivores).	List examples of plant feeders. Discuss.
(a) the plant eaters (herbivores)	Operationally define plant eaters (herbivores).	Take a field trip to a park or meadow. With a small net, collect plant feeders and samples of their food. Record data from trip. List all plant eaters seen, and their food. Farm animals: List plant eaters. Discuss. Research to clarify. Zoo animals: List plant eaters. Discuss: young animals are dependent or independent. Art: Paper mache or wire sculpture of farm or zoo animals. Film: Assiniboine Park Zoo, We're at Home, We're from Afar. Collect aphids and examine them with a hand lens. Variations may indicate changes in life cycle. Draw as many kinds as possible. Place insects collected above in a large terrarium planted with corn, rye, wheat, birdseed. Record which plants the insects prefer. Observe population increases and declines. (Note: Plants on which organisms were found should also be planted in terrarium). Language Arts: Aphids can be placed in a container on overhead projector. Activity can be observed and poetry could result.
(b) the animal eaters (carnivores).	Infer that some organisms are animal eaters (carnivores).	Introduce animal eaters by means of pictures, films. Discuss animals observed and the food eaten. Introduce the term carnivores. List animal eaters mentioned. Animals that eat both plants and animals can be listed as omnivores. Observe their teeth. Films: Bumble Bee. Resource person may be obtained from Canadian Bee Association.
3. Animals may interact in a predator – prey relationship.	Observe and classify predator – prey relationships.	Have students identify predators and prey from among the animals listed in the activity above. Discuss this population interaction, e.g., too many wildcats, too few raccoons to feed upon.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Place ladybugs in a terrarium with aphids. Observe and record results. Place chameleons in terrarium with grasshoppers, beetles, crickets. Observe and record population interactions.
	Identify plant eaters, animal eaters, or eaters of both plants and animals (omnivores).	From various activities above, maka a chart listing animals and check off whether they are plant eaters, animal eaters or both. Language Arts: Each student researches one animal found in Manitoba, writes a report and draws a picture on stencil. End product is a good overview of animals of the area since each student gets a book.
4. Food is cycled within an environment (producer – consumer – decomposer).	Classify plants and animals according to feeding behaviour, i.e., scavenger or decomposer, producer and consumer.	Discuss animals which feed on dead animals. Introduce term "scavenger". List scavengers.
	Observe and record changes in decomposing matter and interpret the data.	Observe a terrarium or aquarium for dead organisms. Record changes in organisms. Introduce the term "decomposer". After discussion, ask the students for examples of decomposers. Discuss how decomposers interact with living populations.
		Start a bread mold colony: Moisten a slice of bread; expose it to the air for several hours, and then place it into a container with a tight lid. Draw a diagram. Observe daily for one week and make a diagram. Keep bread moist. Discuss results. Put spiders into a shoe box. Place black paper onto the back and cellophane on the front. Place inside twigs, water, and flies for food. Watch the spider make its web.
		Place plant (potato, banana, rice pudding) and animal matter (frankfurter) into a small covered jar. Add some spores from a bread mold colony. Observe and record changes. Discuss population interactions.
5. Organisms interact with each other in a food chain.	Identify organisms which make up a food chain.	Introduce a food chain by placing the term or a picture of a caterpillar on the board. Ask what a caterpillar eats. Record and join with an arrow. What eats a caterpillar? Do the same activity using a leaf caterpillar, frog, snake. Have students suggest other animals and build the food chain.
	Observe a food chain.	Food chains in the classroom: Observe terrariums, aquariums for food chains. Record. Art: Murals of food chain.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
6. Food chains form more complex food webs.	Communicate food webs by means of diagrams.	Initial activity: Draw a food web on the board. Start with an animal, what it eats, what other animals eat its food, what animals prey on it. Construct and label food web organisms as scavenger, decomposer, prey or predator to show population interactions. After this, go out into the playground or a wooded area and have students record their observations.  wolf fox rabbit man lettuce cow mosquito caterpillar grain bird
7. Populations interact to cause environmental changes.	Observe how one kind of animal can cause environmental changes.	Construct a box with sand at one end and earth at the other. Place earthworms on the sand and on the earth. Observe. Film: Boomsville
	Infer the interactions of one kind of organism with its environment.	Discuss the effects on the environment when man builds a city. Make before and after pictures of different environments, e.g., clear city/smoggy city. Discuss how organisms in the various environments interact to cause change.
8. Humans interact with other organisms to become part of a network of populations.	Infer how humans interact with other organisms.	Investigate and discuss topics such as consumable resources versus renewable resources.
	Value: Since some resources are limited and man interacts with his environment, he must do so in a responsible manner.	

Changes in Matter and Energy: Sound

Main Concept: Energy transferred from one particle to another creates sound.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Sounds can be used to identify objects.	(a) Infer the nature of an object using only the sense of hearing.	Place different objects such as marbles, thumb tacks, and macaroni in six small metal containers. Have students rattle the cans rapidly and slowly, guess what is in each container, and how many of the objects are in each. Film: Sounds Around Us. Art: Collect seeds, pods, acrons, or cones. Use in art exercises or make mobiles. Acorns can be used as heads for people, monkeys, etc. Seeds and pods can be used to make flowers.
	(b) Infer the nature of an object or event from familiar sounds.	Have students describe an athletic contest or cultural performance. Have this description repeated with the instruction that the student describe every different sound he/she would hear. Use a tape or video-tape recording. Take the students out for a walk and have them record on paper as many sounds as they can, e.g., rustling leaves, flapping flag, passing cars, people talking, etc. Discuss findings in class. Have students blindfold themselves and observe as many sounds as possible in the room.
	(c) Infer the direction from which sounds are produced.	Place a blindfolded student in a circle of other students. One student in the circle makes a sound. Blindfolded student points to the source of sound.
2. People vary in the way in which they can identify sounds.	(a) Infer that we can eliminate the effect of sound when we concentrate on something other than the sound.	Have the students do their favourite quiet activity, e.g., reading a book, drawing a picture and make a note of all the sounds they hear. After ten minutes, have the students tell you all of the sounds they hear while doing their activity. Point out that those who heard the most sounds may have been the most distracted from their task. Film: Sound waves and their sources.
3. Sound is caused by vibrations.	(a) Infer that vibrating objects cause sound.	Hold a ruler on your desk. Let most of it stick over the edge. Snap the free end down. Make your own musical instrument, e.g., hammer spikes into a block of wood and stretch elastics across the nails. Ask the music teacher to help the students compose a tune on the instrument they make.

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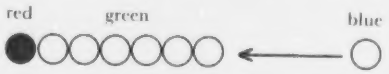
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Trace the path that vibrations can make: Hold a piece of chalk loosely and then tightly, and run it across the blackboard in such a way that dots representing the vibrations are left behind. Note the different sound that accompanies each track made by the chalk. Art: Cover a used light bulb with paper maché. When dry, give it a sharp tap on the table to break the bulb. Now decorate. Makes a good maracas. Other instruments can be made. Make up a song and record it. Recycle material and produce a junk artifact.
	(b) Observe the grooves in a record.	Use a magnifying glass to look at the grooves of a record. Social Studies: Research the history of the first record player.
	(c) Infer that the grooves in a record cause vibrations which produce sound.	Make a cone out of paper and put a pin in the tip of the cone. Turn the record player on and play an old 78 or 45 r.p.m. record you no longer want. Stick pin in grooves and observe sound of pin tracing. Film: Learning About Sound.
4. The pitch of a sound is determined by the number of times an object vibrates in a given period of time (frequency).	(a) Measure the lengths of the vibrating object and relate the length to the pitch.	Extend a ruler over the edges of the desk. Vibrate the ruler at specified lengths. Note the length and speed of vibration and the pitch.
	(b) Infer that pitch is related to the length of a closed column.	Fill eight glasses or bottles with increasing amounts of water. Tap the rim of the glass with a nail or pencil. Note the pitch of each glass. Blow across each bottle and note that now the fullest bottle has the highest pitch. Music: Music nails can be made by hanging a variety of different sized nails by nylon thread from a coat hanger. Now use some sort of banger and listen to the music.
	(c) Control the variables which affect the pitch of sounds.	Use different lengths of large drinking straws with flattened ends. Blow through the straws. Make a musical scale with different lengths.
5. Sound energy travels in all directions from a source.	(a) Observe that you do not have to be in the direct line of a sound source in order to hear it.	Have students stand back to back and ask each in turn to speak. They note that they do not have to be facing the sound to hear it. Social Studies: Jungle telegraph. Make up a code and then send message.
6. Sound waves become less audible as they move further from the source.	(a) Observe that sound waves can be heard more easily over great distances when the waves are confined.	Have students talk to each other from around corners. Note that they don't have to be in a direct line with the sound source to hear it. Have students walk away from a ticking clock until they can no longer hear it. From that point, listen for the clock with a long tube (made of masking tape and rolls from paper towels), held between their ear and the clock.

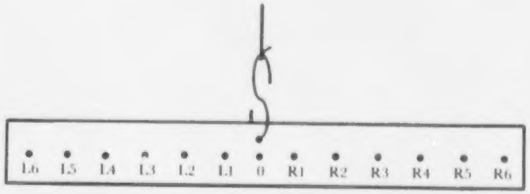
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Continue moving away and lengthening the tube until the clock can no longer be heard even with the tube. Compare the distances using the two systems. Health: Teach the function of the outer, middle, and inner ear in hearing. Make a model of the ear. Film: Ears and Hearing. Film: Pollution; Air, Water, Noise.
7. Sound does not move as quickly as light.	Observe that sound requires measurable time to travel between two points. Light appears to be instantaneous.	Using a track and field starting pistol or small firecracker, have students observe that the smoke shows before the sound arrives. Students should be several hundred metres away from the sound. Observe thunder and lighting.
8. Loud sounds can be uncomfortable and even unhealthy.	(a) Value: Discuss responsibility for the control of man-made noise.	Discuss noise pollution, e.g., the pros and cons of using motorized vehicles in a wilderness setting.
9. Noise pollution produced by people can be controlled by people.	(a) Observe the environment using the sense of sound.	Go on a walk to discover sounds. Chart the noises you hear in order of loudest to least noisy. Have students discuss how very noisy situations might be rectified. Take a tape recorder along. Language Arts: Creative writing using adjectives to describe sound, adverbs to describe the making of sound. Alliteration poems: "The sound of the rustling leaves on the rolling branches made the city seem serene".
10. Solids generally conduct sounds better than liquids or gases such as air.	(a) Observe the intensity of sound through solids, gases and liquids.	Using two tin cans and at least 10 metres of durable string, construct a telephone. Rub the taut string with an eraser, a paper clip, a pencil, or other materials. Social Studies: Research the history of the first telephone.
	Control variables which affect the conduction of sound.	Change the size of the cans. Use two larger cans. Use a large can and a small can. Observe which is the better receiver and which is the better sender. Film: Development of Communication. Fill plastic bags with different materials, e.g., a book, water, air, helium, and a piece of iron. Hold a ticking alarm clock up against these bags. (Keep clock same distance away from ear). Cover the other ear if possible. Note which substance best transmits the sound. Music: Whistles can be made out of licorice sticks as well as straws of various lengths. Film: Music — Wind Sounds

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
11. Some objects conduct sounds while others absorb sound.	(a) Observe the sound conductivity of various materials.	Have one student tap on a long metal fence at a point a great distance from the other students. Students then place their ears on the fence to hear the tapping. Place a pillow, a plastic bag of sawdust, or folded drapery material against your ear. Note the muffled sound of the ticking of an alarm clock. Place the clock on a table against a door. Note the conduction of the sound. Using a long block of wood, hammer 3 large, 3 medium, and 3 small sized nails at distances of equal length. Run another nail over the secured nails. Observe the different notes or pitch. Construct other simple musical instruments, e.g., African "Thumb Piano", Ear Harp. Integrate with music by asking music teacher to have students compose a tune on their instrument.
Extension: 12. Sound travels in waves as energy is transferred from one molecule to another.	(a) Observe the nature of a wave.	Pour some water into a large pan until it is about ½ inch deep. Place the tip of a tuning fork into the centre of the pan. Note that the waves move out in a circular fashion in all directions.
	(b) Observe the result of an energy transfer.	Place a red marble in a circle. Shoot it out with a blue one. Film: Energy and Matter
	(c) Infer that sound is an energy transfer from one particle to another.	Line up several green marbles behind a red marble, all touching. Shoot a blue marble at the line of marbles and observe the speed that the red marble moves. 

Changes in Matter and Energy: Structure and Forces

Main Concept: The design, size and materials of a natural or man-made structure will determine the forces it can withstand.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. The structure of an object is directly related to its function.	**Students should be able to:** (a) Observe different objects and contrast their structures.	Study the arrangement of parts of structures to see how structure affects function, e.g., an old wooden step-ladder vs. new metal one, a walnut vs. a peach, picture of an old face vs. a young one. Do this orally. Art: Cut the face of an older person from newspapers or magazine. Cut it in half. Paste a half on paper and let students draw in other side.
	(b) Define operationally a pen and a pencil.	Compare the structure of a pen with that of a pencil to see which is best suited to the function of writing. Note: Some students may feel that a pencil is better suited to the function of writing because it can be easily erased. Some may feel that the pen is best suited because it leaves a permanent record. This of course is important in business transactions. Other ideas could be that you don't have to sharpen a pen. In the case of a fountain pen, the student may say the pencil is better suited to the function of writing because you don't have to carry around an ink supply. Art: Secret writing ½ t. salt ½ t. hot water Mix in top of jar lid. Use a toothpick to write message. Let dry. To make message reappear rub across the paper with pencil lead.
	(c) Observe the inside and outside of three fruits and vegetables to show how the difference in structure affects their function.	Make a longitudinal and cross sectional cut through a cucumber containing seeds. Compare the soft, seed-filled centre to the hard outside skin. Make a longitudinal cut through a carrot. Slice half an orange, or a Spanish onion. Art: Make vegetable prints. Let the vegetable dry well and then print. Green pepper and orange make an effective design.
	(d) Infer the function of different types of skin.	Compare the thick skin of an orange with the thin skin of a grape. Record the weights of the orange and the grape. Leave in a warm area for two or three weeks. Weigh the grape and orange and compare with original weights. Calculate the weight loss ratio using: $\frac{\text{weight at beginning}}{\text{weight after dehydration}}$ Discuss the moisture loss of each fruit in relation to the thickness of the skin.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(e) Infer that root systems transport moisture to leaves.	Place stalks of celery in a container of water coloured red. Observe several hours later. This can be done as a race between two pupils. Cooking: Candied orange peel. Boil ½ cup of sugar and the peel of one orange for 10 minutes at low heat.
2. The balance point of a structure that must be supported will change as forces are applied to it.	(a) Observe that the balance point of a metre stick will change as masses (forces) are added to it.	Find the balance point of a metre stick by sliding your finger under it. Make a balance beam. Art: Mobiles. Place one, two, then three coins on one end of a metre stick and observe what happens to the balance point.
	(b) Predict the corresponding forces required on either side of a balance beam in order to balance it.	Restore the original balance point without removing the coins by placing coins on the other end of the metre stick. Construct a balancing device as follows: On a piece of cardboard, make a pivot hole and 13 equally spaced holes. Suspend with a paper clip and string.  Place a paper clip at R4. Balance by placing a clip on the L side. Place a paper clip at R6. Balance the beam by placing another clip on the L side.

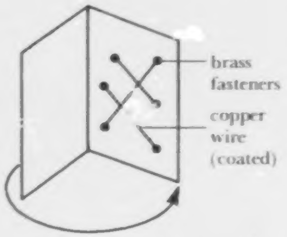
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Place a paper clip at R6. Balance the beam by placing 2 clips at a point on the L side. Have students experiment by placing three or more clips on one side and then balancing by placing clips at different positions on other side.
3. The material from which a structure is made will determine the ability of the structure to withstand force.	(a) Construct various structures made of a given material.	Using plasticine, construct a tower consisting of a single column. See how high you can make it. Use paper shapes to see which will support most weight.
	(b) Observe that the materials used within the structure of a tower affect its strength.	Using plasticine, construct the highest possible tower using four columns and supports. Use plasticine to construct archways and bridges. Test them for strength and improve upon them. Construct the highest possible structure using 50 straws and 50 straight pins.
4. Structures made of the same substance can vary in the amount of weight they can support. The force a structure can withstand is directly related to its design.	(a) Observe and describe the variables in design which affect the strength of a structure.	Using 10 plastic drinking straws and an unlimited number of straight pins, construct a bridge of 1.5 straw lengths. Test the bridges built to see how many washers or other weights they will support. Use textbooks to allow for the bridge span. There must not be a centre support that rests on the desk top. Language Arts: Research the world's free standing structures, uninhabited and inhabited. Design a structure using the smallest number of straws possible that will support a brick 6 cm above the table top. Use glue, pins, plasticine or all of these. The base should be fixed to something on the table. The brick can be glued to the straws.
5. Shape is an important property of any structure used for support.	(a) Infer that the strength of an object is dependent upon its shape.	Using masking tape and a piece of paper, make several structures to see which will support the most weight. (e.g., structures can be cylindrical, triangular, square, etc.) Math: After counting rings, calculate age of tree 15" in diameter, 20" in diameter. Art: Lesson in sketching a tree using charcoal. Project on trees are valuable for shelter belts, timber, etc.
	(b) Observe and measure the effect of additional layers on the strength of a structure.	Using the above, shape several sheets of construction paper to make structures. Test their strength. Make a bar graph of your results.

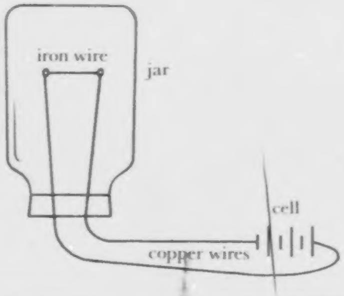
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
6. The layers of a structure may be circular in shape in a cross-sectional view.	(a) Observe the cross-section of a tree. (b) Infer the age of a tree by observing its growth rings.	Observe the dark and light rings of a section of a tree. Count the spring and winter growth rings in a slice of a tree. Divide by two to get the age of the tree.
7. The structure of a tree is such that its base can support the forces exerted on the rest of the tree.	(a) Infer that a tree has more growth rings at the bottom than at the top.	Take the students outside to observe that a tree becomes smaller in circumference as it goes up. Have students suggest why this is beneficial to a tree when it is acted upon by wind.
8. Multi-celled animals have support systems. (a) Some skeletons are inside. (b) Some skeletons are outside.	(a) Observe animals with exoskeletons and endoskeletons.	Look at pictures of animal skeletons or living animals, e.g., exoskeleton – lobster, crayfish, horseshoe crab; endoskeleton – mouse, dog, cat, fish, pupils. Observe that the bones which must withstand the greatest forces are the largest.
9. Bones of birds are more porous than the bones of other animals.	(a) Observe the bones of birds and compare them with the bones of land animals. (b) Infer that the porosity of the bones of birds is an aid to flight.	Place the skeleton of a bird and parts of a skeleton of a land animal in a container of 3% hydrogen peroxide. Leave for two days. Note that the porosity of the bird skeleton leads to its disintegration. e.g., duck, cornish game hen, chicken. Social Studies, Geography: How far does the Canada Goose or duck fly? Film: Birds and Migration

Changes in Matter and Energy: Electricity

Main Concept: Electricity is a form of energy. Electrical energy can be changed to heat energy and light energy.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	The student should be able to:	
1. A battery or a dry cell (hereinafter called a cell) can be a source of electricity. The path through a bulb, cell and their connecting wires is called a circuit.	(a) Predict the ways in which a single bulb can be lit using one cell.	Using a cell and copper or aluminum wire, join the bulb to the cell so that the bulb will light up. Art: Divide the class into groups. One group could work on a mural depicting a home without electricity or appliances. The other group could illustrate today's home and conveniences.
2. Electricity cannot flow if there is a gap in the circuit. A switch can either open or close a gap thereby controlling the flow of electricity.	(a) Observe how a switch affects an electrical circuit.	Using a single cell and a single bulb, make a circuit that runs through a switch. Note what happens when the switch is opened and when it is closed.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
3a. Several cells connected can make a bulb light up more brightly.	(a) Observe the various ways in which several cells can be joined to one bulb.	Join two, three, then more cells in series and in parallel to a single bulb. Note which arrangement produces the brightest light. Caution: Find out how many cells it takes to burn out a bulb. They are expensive.
Cells may be connected in two basic ways: series or parallel.	(b) Predict which method will give the brightest light.	See how many cells using both arrangements will light up an ordinary household bulb (25 watt).
4. Several bulbs can be connected to one cell in two basic ways: series or parallel.	(a) Observe the number of bulbs which can be lit in a series circuit; in a parallel circuit.	Using series and parallel circuits, light as many bulbs as possible with one cell. Note the brightness of bulbs. Note what happens when one bulb is removed from each type of circuit. Circuit Board: Students enjoy making puzzles and exchanging them with classmates.
	(b) Observe that the removal of one bulb from a series circuit causes all of the bulbs to go out, but the removal of one bulb in a parallel circuit does not.	
5. Some materials are conductors of electricity; others are insulators of electricity.	(a) Compare materials which conduct or insulate (stop the flow of electricity).	Use an electrical circuit that contains a switch. Use materials such as metals, plastic, wood and glass to bridge the gap of the switch. Note which materials allow the bulb to light up.
	(b) Classify materials as either insulators or conductors of electricity.	Classify the materials tested in (a) as insulators or conductors.
	(c) Predict the effect on a circuit as the length of a wire is increased. Infer that lenghtening the wires in a circuit will increase resistance.	Make a circuit using No. 14 or No. 16 copper wire. Notice what happens to the brightness of the bulb as you increase the length of the wire repeatedly by 30 cm.  Tape the wire shut and test on brass fasteners with a battery and bulb. Physical Education: Pretend that an electric charge is passed through students in a chain. Language Arts: Write a letter to Hydro inviting someone to speak on transmission of electricity. Social Studies: Map where electricity flows.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Classify metals according to their ability to conduct electricity.	Make 2 circuits using copper wire in one and aluminum wire in the other. Compare the brightness of a bulb in the two circuits. Replace the aluminum wire with an iron wire and then with a nichrome wire. Compare the brightness of the bulb each time.
6. The flow of electricity through the filament in a bulb heats the filament and produces light.	(a) Observe and diagram the structure of a light bulb.	Use a magnifier to observe a small bulb and a household bulb.
	(b) Infer that the filament in a flashlight bulb is part of the circuit.	Observe a burnt-out flashlight bulb with a magnifier.
	(c) Operationally define a light bulb.	Insert two bare copper wires through cork or clay. Join with a very thin iron wire. Connect to a cell and cover with a jar to make a light bulb. 

Earth, Space, and Time: Water and Land

Main Concept: Water is a liquid which erodes the land. Water supports and transports materials.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Liquids have unique properties (review of grade 2 concepts).	(a) Observe the properties of liquids: –they pour, –they drip, –they can be stirred, –they have weight, –they are wet, –they take the shape of the container in which they are.	See activities under grade 2 (Properties of Matter).

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. Water has weight.		Ask students if water has weight. Pour water into a pail until it is too heavy for them to carry. Have students weigh empty containers. Weigh the containers with water in them. Have students weigh dry sponges. Then, wet the sponges, reweigh and note the increase in weight. Art: Collage of liquids.
3. Material heavier than water can be made to float.	(a) Predict the shape of a clay boat which will support the greatest mass. Measure the capacity of the boat by using marbles as a standard unit. Predict which objects will sink and which will float.	Have students predict the most efficient shape of a boat. Then give each pair of students 50 g. of plasticine and have them build the boat that they feel has the best design to support the most weight. Test for the number of marbles or washers it can support. Do a demonstration with a large transparent tub of water (try a battery jar or aquarium) and have students predict which of the following will float: an apple, orange, pea, block, ball, full sardine can, etc.). Have students bring objects and do their own investigations. Film: Boats and Ships.
4. Adding air to objects helps them float.	(a) Predict the balance of air and water which will cause a hose to sink or float.	Use foot-long transparent hoses with corks that fit the ends. Predict and then investigate the amounts of water needed in the hose to cause it to sink or float. (Cartesian diver).
	(b) Measure the relative proportion of air and water required to sink the hose.	Fill the hose with water until is sinks. Measure this amount of water. Fill the hose completely. Calculate the volume of air by determining the difference between the two amounts of water.
5. Rainwater falls onto the land and runs downhill to collect into lakes, rivers, and finally the sea.	(a) Observe the effects of rainwater on the local environment.	Walk in the school yard just after a rain to observe effects of rain on the landscape and find out where the water goes. View pictures of the effects of rain on the landscape, noting specific features: lakes, rivers, gully, watrefall, streams, brooks, ponds, sea. Do an investigation simulating a ridge and a divide. Use aluminum foil on a newspaper surface. Make a ridge across the foil and drop water from a sponge. Note where the divide in the water flow is formed. Language Arts: Write a descriptive story of "After the Rain". Film: Paddle to the Sea; Water, Water Everywhere.
6. Moving water wears away the land.	(a) Observe the erosive effects of flowing water and the formation of land features.	Construct a mini "mountain" in the school yard and direct the flow of water from a hose on it. Set certain features upon this mountain: trees, grass, rocks, buildings, etc. Note the

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		varying effects of the water on the soil. Increase and decrease water pressure. Classroom activity: Make a stream in a box and do the above activities.
7. Moving water makes rocks smaller	(a) Predict the effects of movement in water upon rock particles.	Set up controlled experiments using three plastic containers filled with similar pebbles (use soft sedimentary rocks). Put water in #1 and shake 1,000 times. Put water in #2 and do not shake. Put nothing in #3. Compare shapes of pebbles at end. Then shake #1, 3,000 times and #2, 2,000 times. Note shapes of pebbles and muddiness of water (rock tumblers can be used). Film: Water and What It Does Art: Use rocks from tumbler for rock art. Paint with canned milk and tempera paint.
	(b) Infer the effect of movement of rock particles in rivers and streams.	Take students to observe pebbles in a stream or lake. Have them collect pebbles and infer their history.
8. Moving water can hold more material than still water.	(a) Observe that moving water holds more material than still water.	Fill a large jar with sand, clay and pebbles mixed with a large quantity of water. Roll the jar along the floor and note that most of the material is carried in the water. When the jar stops, note that nearly all of the material sinks to the bottom. Creative Writing: "My Pet Rock" Social Studies: Study formation of deltas, floodplains and other land forms.
9. Some water sinks into the land and some evaporates.	(a) Observe the effects of evaporation and absorption on water levels.	Cut ends out of a large juice can. Set firmly on the ground and fill with water. Observe results at regular intervals. Place a similar juice can on the ground with only one end cut out, and fill it with water. Compare results.
	(b) Measure the amounts of evaporation.	Mark a puddle shoreline each half-hour after a rainstorm. A contour map should result after the puddle is completely evaporated.
10. The ground holds water in the spaces between pebbles and soil particles. This is called ground water.	(a) Observe that there are spaces between soil particles which could hold water.	Fill a jar with pebbles. Hold hand on top and invert jar in basin of water. Keeping opening of jar below the water surface, allow pebbles to fall out. Note amount of water which fills the jar. Account for the air space at the top of the jar.
11. Water is a precious natural resource.	(a) Value: To relate information learned about water and land to human activities and problems.	Discuss the needs for clean water for human activities. Encourage students to bring in news about water and water pollution.
12. Water evaporates to form clouds. The clouds move and the water falls to the earth again (water cycle).	(a) Observe the changes in water as it goes through its cycle.	Teacher Demonstration: Using an electric hot plate, heat a tin of water till boiling and note water vapour or steam; place a pan of ice over the steam and note results.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
13. Mankind has serious water problems. Clean water is an essential resource for man.	(a) Value: Respect and understand the value of water to humanity and all life.	View pictures of films of flooding, drought, pollution of water. Visit a water reservoir and purification facilities. Have presentations to the class by community resource people, e.g., local water works staff. Film: Rivers; Masters or Servants (From Department of Mines, Resources and Environmental Management).

Grade Five

4

Grade Five

The grade five program is based on three themes taught in five units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
    Unit 1 Adaptations to the Environment

Theme 2 **Changes in Matter and Energy**
    Unit 1 Forces and Motion
    Unit 2 Physical and Chemical Changes

Theme 3 **Earth, Space, and Time**
    Unit 1 The Changing Earth
    Unit 2 The Earth in Space

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested. A sequenced statement of core concepts and processes is found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled ***Process Development*** which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Grade Five

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Adaptations to the Environment		5	5	Coloured Things Minibeasts Ourselves	Crayfish Eggs and Tadpoles Mosquitoes Behaviour of Mealworms Animals in the Classroom
Forces and Motion	5	5	5	Structure and Forces	Kitchen Physics
Physical and Chemical Changes	5	6	5	Metals/Background Information Metals	Mystery Powders Coloured Solutions Gases and Airs
The Earth in Space	3,5,6	5		Time	Daytime Astronomy
The Changing Earth	5	4		Change Stage 3 Like and Unlike	Rocks and Charts Tracks
Extension Unit Cells and Organ Systems	4	5	5		Small Things

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	SCIENCE IN ACTION	SPIES	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Adaptations to the Environment		Ecology in Your Community Birds Your Senses		Studying Mammals			
Forces and Motions					Force, Work, Energy		5
Physical and Chemical Changes	The Rise and Fall of A Yeast Community	Your Senses			Matter, Matter Everywhere	6	
The Earth in Space					Oceans, Space	6	5
The Changing Earth					Earth, Weather	5	5
Extension Unit Cells and Organ Systems		Your Senses	D/E		You & Me	5	6

Grade Five

Interdependency and Interaction among Organisms: Adaptations to the Environment

Main Concept: Adaptations help organisms survive in their environments.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. An adaptation is a structural or behavioural change in an organism which improves its ability to survive in its environment.	**Students should be able to:** (a) Observe adaptations of some organisms.	Students observe a characteristic in an organism, e.g., cats' claws, birds' flight, root of a plant, the height of a tree, and discuss it in terms of the organisms natural environment. Students should note that the survival of the organism is dependent on its adaptations to its environment. Note: Living organisms are best for this activity. Have a "pet day" or take a walk in the school yard to observe animal or plants organisms found there.
	(b) Identify specific adaptations of an organism.	Students working in small groups choose an organism for study. Needs of the organism are listed along with characteristics of its natural environment. Students try to discover which adaptations help the organism survive.
	(c) Infer that adaptations may be structural.	Students examine a specific structural adaptation of an organism such as dogs' hair or flower petals and discuss how this particular physical characteristic is advantageous to the organism.
	(d) Infer that adaptations may be behavioural.	Students examine a specific behavioural adaptation of an organism such as a cat's stealth or a bird's song and discuss how this particular behavioural characteristic is advantageous to the organism.
	(e) Operationally define an adaptation as any characteristic of an organism which provides it with an advantage for survival in a specific environment.	Students observe a specific organism and list as many adaptations as possible. Each adaptation should then be defined in terms of its function. Through discussion of the function of each adaptation, students should infer how adaptations to an environment give the organism an advantage for survival in that environment.
	(f) Predict the most useful structural and behavioural adaptations an animal should exhibit in any given environment.	Students are assigned a specific environment, e.g., pond, desert, tundra, and are asked to design and draw a picture of an imaginary animal that could survive in that particular environment. Students should be prepared to discuss the features of their animal and explain reasons for their choice of features. Film: Sandcastles This activity may also be done with plants.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. Organisms may adapt by changing a specific structure in different ways.	(a) Observe feet in different animals and compare their function.	Students collect pictures of different animals which show clearly the type of foot the animal has. These pictures are then glued to a large wall mural broken up into several sections to show the functions of various types of foot. Some functional groupings are: • grasping, • silent movement, • movement in water, • tearing flesh, • digging, • balancing Note: Some animals have feet which will fit in more than one category.
	(b) Observe different types of body covering of animals and compare their functions. Infer the advantages and disadvantages of several.	Students using pictures or drawings compare the body coverings of a fish, birds, and mammals. Detailed drawings can be done to show scales, feathers, and hair. Discussion of these body coverings should lead to a listing of the advantage of each type of body covering and how it helps the organism to survive in its environment. Students make up questions for each other such as: "Why are frogs not covered with scales?" "Why don't squirrels need shells?" Games can be made up with these questions and their answers.
	(c) Observe different types of roots in plants and compare their structure. Infer the advantages and disadvantages of each type.	Students examine the two basic types of plant roots: a tap root (dandelion), and a filamentous root (grass). Comparisons should be made in terms of how each type of root helps the plant gather moisture. It should be pointed out that both plants may exist in the same environment while each acquires water from a different soil layer.
	(d) Observe different types of plant stems and compare their function.	Students observe the stem of a tree and a dandelion and compare them in terms of length, thickness, and flexibility. Intergrate with mathematics: Find the height of a tree. Examine height to thickness ratio. This may relate to the flexibility of the tree.
	(e) Infer reasons for specific adaptations of plants or animals and communicate these reasons.	Pairs of students go outdoors and select a plant or animal living in the local environment. Each pair of students formulates a question about the structure of their chosen plant or animal. One student in each pair remains with the organism as his partner goes in turn to each plant or animal chosen by his classmates. As each student comes to a new organism the "question" is posed and his answer recorded. All students should have a turn at each location. Answers may be used for further discussion and for evaluation of students' progress.
3. Organisms may adapt by changing their behaviour.	(a) Observe different types of movement in animals and compare their function.	Students observe live animals or animals on films (e.g., horse, turtle, snake), and classify them as slow moving or fast mov-

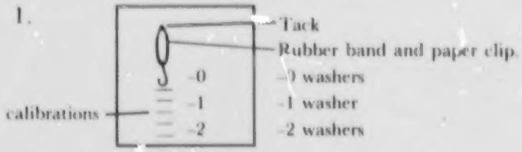
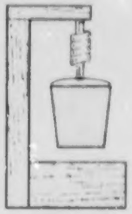
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		ing. Discuss how the animal is able to survive in its environment. Animals which do not move faster than their enemies must have other adaptations for self protection. Animals which are slower moving than their food must have other adaptations which give them an advantage over animals which they eat. Note: Students may point out that the behavioural adaptations of locomotion are dependent upon structural adaptations of form. This is a valid argument which leads to the question "which came first?" Investigations of animals which have evolved from the land back to the sea (e.g., dolphin, seal, killer whale) provide a good basis for pursuit of this question.
	(b) Observe coniferous and deciduous trees and compare the benefits of each type of adaptation.	Students observe coniferous and deciduous trees and their distribution in terms of both latitude and altitude. Benefits of each of these adaptations should be listed with particular emphasis on moisture availability and climate. Students examine a broadleaf and a pine needle under a magnifier and with a microscope. Similar structures should be identified and compared. Integrate with social studies.
4. Adaptations help in the reproduction of organisms.	(a) Observe and classify adaptations that help in seed dispersal for plants.	Individually or in groups, students make a seed collection and classify each type of seed in terms of the way it is dispersed in nature. Students should record where the seeds were found and if possible identify the plant from which each seed came. Students should observe each seed carefully to identify those structures which help in its dispersal. Students should try to find relationships between where the plant grows and how it disperses its seed. This activity should be done in the autumn. Seeds are dispersed by being carried by wind, water or animals.
	(b) Observe adaptations that help in the survival of a chicken egg.	Students examine a chicken egg and then crack it into a bowl. Students examine the shell and the membrane under the shell with a microscope. Then examine the yolk and discuss where the chick embryo obtains its food for growth and development. Integrate with family life education.
5. Organisms show adaptations to environmental change.	(a) Observe patterns of behaviour in animals and relate them to survival in a changing environment.	Students observe live or on film migration of birds, salmon, monarch butterflies or caribou. Discuss environmental changes which cause migration to occur. Construct a map showing the major migration routes of a particular animal. Students observe animals which hibernate in the winter months, e.g., insects, bears, squirrels. Discuss environmental changes which cause hibernation to occur. Integrate with social studies.

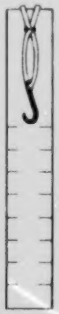
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Infer which adaptations allow animals to hibernate, migrate or remain active during the winter months.	Students construct a chart listing characteristics of animals which hibernate, migrate, remain active. Students are presented with information about a little known animal and are asked to predict its seasonal behaviour based on its adaptations.

Changes in Matter and Energy: Forces and Motion

Main Concept: Objects in a system do not change their motion when forces are balanced. Change of motion is a result of unbalanced forces in a system.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Pushes and pulls, hereinafter called forces, are exerted on all objects around us.	(a) Observe forces acting on objects and operationally define "force".	Look at pictures that indicate forces. Note what is causing the force and on what object the force is acting, e.g., vehicles, sports equipment. Operationally define a force as a push or a pull on an object. Let students make a game using two toy cars, a cardboard maze, and a magnet.
2. Forces can put an object in motion and change the motion of the object. Forces can speed up and slow down an object and can cause an object to turn.	(a) Observe forces causing an object to be put in motion and to change its motion (direction or speed).	Students place a rubber ball on a table. Blow on it to start it moving. Blow on it to make it move the opposite way and in a circle. Alter the force of your breath to speed up and slow down the ball. Give the students a bar magnet and a steel ball. Start the ball moving by using the bar magnet. Make it move in the opposite direction. Make it move in a crooked path and in a circle. Holding the magnet different distances from the ball, alter the speed with which the ball moves.
3. The force that causes an object to speed up or slow down is called an "unbalanced force".	(a) Predict the effects of forces upon objects and identify the variables (size, strength of student and position of student) that affect motion. Infer that varying the height of the drop will vary the force exerted by an object. Infer that different masses exert different forces when falling.	Have pairs of students engage in push of war contests. Students face each other and place their right feet side by side, touching. The right hand of each pushes on the palm of the right hand of the other. A third student says "go". When either of the pair moves his foot or lets his hand touch the floor, that person is the loser. Students should note that even though the loser was originally applying pressure in one direction, the winner made the loser change the direction of his original force.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
5. A spring scale can be used to measure the weight of an object. The weight can be expressed as a function of the distance an object moves the spring.	(a) Construct a device for measuring the mass of everyday objects.	Students should work in groups to make at least one of each of the following four spring scales. The scales should be calibrated according to a standard measure and the distance the standard measure moves the spring. 1.  Tack Rubber band and paper clip -0 -1 -2 -0 washers -1 washer -2 washers calibrations Social Studies: Research and write on first methods of weighing. Film: Story of Weights and Measures. 2. Fill a large juice can with sand or another heavy material. Secure one end of a hacksaw blade to the top of the can so that it runs across the diameter of the can. Hang a paper cup from the other end of the hacksaw blade by means of three 10 cm strings. Place a piece of cardboard beside and slightly behind the paper cup. Make a mark on the cardboard to coincide with the top of the paper cup; this will be the zero mark. Use washers or other standard weights to calibrate the cardboard. Each time a weight is added, a line is made to coincide with the top of the cup. Record the standard weights on the cardboard. 3. Nail a long piece of wood vertically to a wooden block base. Use a metal bracket or a small piece of wood from which to suspend a spring of medium strength. Attach a cup to the bottom of the spring. The top of the cup will coincide with the zero point which will be calibrated on the piece of wood. Use a washer or any other standard weight to calibrate the spring scale on the strip of wood.  4. Fold a file card in half and insert an equal sized

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		piece of cardboard or other heavy material to reinforce it. Fasten the open edges with tape, glue, or staples. Punch a hole in the top of the card and insert a rubber band through it. Attach a paper clip to the rubber band. Use a washer or other standard weights to calibrate your spring scale. A modification of this spring scale can be made: If the rubber band is cut so that it is only a single strand rather than the complete double strand, it can measure smaller weights. In both cases the spring scale can be calibrated by having zero correspond to the bottom of the rubber band. 
	(b) Measure weights with a spring scale constructed by the students.	Students now use the spring balances to measure the weight of everyday objects with reference to the calibration scale.
	(c) Graph force and distance relationships.	Students now make graphs of force in washers vs. distance the spring stretched.
	(d) Infer that the distance an object moves a spring in a scale is a method of measuring the weight of the object.	The home-made spring scales may be standardized by weighing the washers on a gram scale and transferring the weight in grams to the home-made spring scale. Note: Converting the number of washers moved or the distance moved in cm to the weight in grams could be a good exercise in the teaching of fractions.
6. The mass of an object can be measured with a balance beam.	(a) Master the same skills as for the investigations with the spring balance.	Construct a balance beam. Do the same activities for the balance beam as for the spring balance. Physical Education: Work with the balance beam.
7. All forces have direction. It can be represented by arrows.	(a) Observe and record the direction of force applied upon an object.	Place a piece of cardboard under the wheel of a bicycle. Turn the pedal and note which way the cardboard moves.

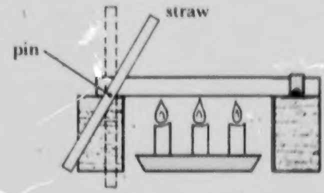
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Stand on a piece of cardboard. Take a very big step. Note which way the cardboard moves. Show students pictures of forces acting on objects. Have the students draw arrows to show which way the forces are moving. Music: Make a musical instrument using elastic bands.
8. When a force acts through several objects (such as the links of a chain), it is transmitted through each with equal strength.	(a) Observe the effect of a force on a series of several objects.	Attach a link of five identical elastic bands to a hook. Note that each stretches the same amount when a strong pulling force is applied.
9. The force an object can exert or withstand depends upon the strength of the object.	(a) Observe and record the strength of materials with reference to forces that they can withstand.	Wrap a length of various threads and strings around a desk. Tie a plastic pail to the strings one at a time. Fill the pail with calibrated weights until the thread or string breaks. Do this with each string or thread. Record the maximum amount of force each can exert or withstand before it breaks. Make a bar graph to show your results. Film: Energy and Work. Energy and Matter.
10. When an object exerts a force on another object, the latter object exerts an equal and opposite force if the system is at rest.	(a) Infer that balanced forces act equally in opposite directions.	Have pairs of students of approximately the same weight hook up a pair of heavy duty spring scales. Have the students pull in opposite directions. Have two other students take the reading of each scale. Note that each scale reads the same if the students are not moving.

Changes in Matter and Energy: Physical and Chemical Changes

Main Concept: Changes in matter can be classified as physical or chemical.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Some physical properties of objects can be observed using the senses.	(a) Observe the physical properties of some everyday objects by the use of the senses.	Seeing: Observe the characteristics of colour, shape, size, rough/smooth, dull/shiny, transparent/opaque, bouncy, liquid/solid/gas. Art: Make a collage of the dominant area of one of the senses, e.g., sight—flowers, birds, etc.; sound—records, radio. Feeling, touching or lifting: Observe an object as to hard/soft, smooth/rough, cold/warm, stretchy, heavy for its size/

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		light for its size. Film: Learning to Use Your Senses. Hearing: Observe whether the object ticks, rings, rattles, hisses or makes no sound. Smelling: Smells/does not smell, sweet/sour, clean/dusty, pleasant/pungent. Caution: Instruct children when observing through the sense of smell, never to put the nose directly near the source, but to waft the odour toward the nose with the hand. Integration: Since the basis for observing physical properties is largely based upon opposites, this may be a good lead in to the study of antonyms in language arts. Tasting: Observe tastes. Sweet/sour, smooth/bitter, cold/hot. Caution: One should never taste an unknown substance. Beware of allergies to certain foods and diabetes.
2. No two kinds of matter are alike in all their properties.	(a) Observe and compare the properties of different kinds of matter.	Observe equal amounts of white sand, sugar, and salt to see if you can identify them. Use your senses of sight, touch and smell. Look at the materials listed above under a microscope or magnifying lens and rub samples of each between your thumb and forefinger. Health: Locate origin of taste sensation, e.g., different area for different taste (sour, sweet).
	(b) Infer that each object has one or more properties which identify it.	See how much of each will dissolve in a glass of warm water. Weight equal samples of each. Observe the odours of the samples. Look for differences in whiteness. Note whether they are shiny or dull. Students should note that even though all three objects have similar properties, each has unique properties.
3. Objects can be classified according to their properties.	(a) Observe, measure, and classify objects according to common properties.	Use the following criteria to compare and classify tool steel, cast iron, a glass tumbler, bricks and cotton. – strength or the resistance of the object to breakage; – stiffness: the resistance to bending; – brittleness: the liability to crack when bent. Film: Learning With Your Senses.
	(b) Observe, measure and classify metals according to their hardness.	Try to scratch different metals using a fingernail, a brass or copper pin, a file and an iron nail. Make a scale of hardness according to the ease with which the objects can be scratched.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
4. The physical properties of an object can undergo change. This change can usually be easily reversed.	(a) Infer on the basis of evidence, that the changes are physical.	Stretch a rubber band, or hammer or coil a copper wire. Work with modelling clay or plasticine. If dried, modelling clay does not easily return to its original shape. Melt wax in a pot. Pour it into a container. Note the physical change from solid to liquid to solid. The students can make molds of animals or rings. Caution: Liquid wax is extremely flammable. Integration: Art; Make candles. Demonstrate: Boil water and hold a cold object over the steam. Note the change from liquid to gas to liquid. This may be done with ice so that the physical change of solid to liquid to gas to liquid can be observed The reverse, that is, ending with ice, may also be done. Language Arts: Write an essay about different uses of different stages of matter. Place a thin metal rod on two blocks. Firmly attach the rod to one of the blocks. Stick a pin through a straw and place the pin under the rod on the other block. The pin will then be between the rod and the block. Place three lit candles in a pan under the rod. Note that the straw moves from a vertical position to a clockwise position as the rod expands. Quickly cool the rod so that it contracts. Note that the straw swings back. 
5. Liquids can be mixed with liquids to produce a physical change.	(a) Observe the mixing of liquids and infer that heat and force affect the rate of mixing.	Place a drop of food colouring into a clear container of water. Repeat this procedure but this time drop the food colouring into the clear water from a distance of 100 cm. Repeat the entire procedure using a drop of heated food colouring. Repeat with hot water and cool food colouring. How can the food colouring be obtained easily from the mixture of water and food colouring? (Heat). Is quicksand a liquid or a solid? Research needed!

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
6. A solid mixes rapidly with a liquid because the surface area of the solid increases.	(a) Observe that a powdered or granulated solid will mix more rapidly with a liquid than would a large piece of the same solid. Infer that surface area (or size of particles) affects the rate of dissolving.	Place a large piece of hard candy in a container of water. Crush the same amount of the same candy and place it into a second container of water. Note that the solution containing the small particles will become clouded more rapidly. It can be shown that this is a physical change by allowing the solution to evaporate slowly. The candy will remain in the container when all of the water has evaporated. Film: States of Matter.
7. Chemical changes produce new materials with different properties. Some chemical changes can be reversed.	(a) Observe that a gas can be introduced into a liquid and infer that the introduction of the gas produces a reversible chemical change.	Pour water into two small containers. Put enough bromothymol blue into each container to get a strong blue colour. Blow through a straw into one of the containers. Note that the colour changes to yellow or green. This is due to the fact that carbon dioxide has been introduced into one of the containers. Leave containers overnight and compare the colours. (This is a reversible chemical change because the carbon dioxide gas leaves the solution). Pour clear soda water into a container. Pour an equal amount of water into another container. Put several drops of bromothymol blue into each container. Note that the soda water turns yellow or green while the plain water turns blue.
8. Some chemical changes cannot be easily reversed. Burning and rusting represent irreversible chemical changes.	(a) Observe materials undergoing irreversible chemical change.	Make a balance scale or use a gram scale. Weigh a sheet of paper. Place the paper in a pie plate. Burn the paper. Weigh what remains. Note the colour, odour, texture, thickness and weight. Place an ordinary iron nail and a painted iron nail in a clear container of water. The paint must be waterproof, e.g., acrylic spray paint or artist's oil paint. This experiment will take several days so allow for other activities during this time. This activity could also be done with steel wool. Language Arts: Write a paragraph predicting what will happen to nail (1) and nail (2). Will it be different?
	(b) Infer that oxygen is consumed in the process of rusting.	Place a ball or wet steel wool in a test tube. Invert the test tube in a tray of water. The water should only be a few cm deep. Note that water rises up the tube as the rusting occurs. Students may infer that water has taken the place of something (oxygen) which has combined with the steel wool to form rust. Definition: Rust is the oxidation of a metal. Oxygen combines with iron to form iron oxide. Test for Oxygen: Burning splinters will be extinguished if no oxygen is present when they are inserted into the tube.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
9. Materials can be classified as acids, bases, or neutral by their effect upon indicators such as litmus.	(a) Observe the effect of various materials on litmus paper or other chemical indicators and classify the materials as acids, bases, or neutral.	Test a number of household and schoolroom substances with litmus paper to determine whether the materials are acidic, basic, or neutral. Students should record the original colour of the litmus paper and the materials used. (Blue to red indicates acid. Red to blue indicates base). It is a good idea to use only one drop of solution in the centre of the litmus paper. Solids must be mixed with water which is neutral. If litmus paper which is the best indicator is not available, homemade indicators can be made from beet juice, cherry juice, grape juice or red cabbage juice. Add the juice (one teaspoon to a half glass of water) and note the colour changes made by known acids and bases. Health: Have students take litmus paper and test all the foods they had for a specific meal. Record findings in written or chart form.
10. When an acid and a base are mixed in correct proportions, a neutral substance (salt) is formed.	(a) Observe the formation of a neutral solution from a combination of an acid with a base.	Mix the following and test with litmus paper to see whether they are acids, bases or neutral. Note how much of each compound must be added to form a neutral compound: – lemon juice and baking soda; – vinegar and soap; – vinegar and household ammonia; – orange juice and garden lime. The stronger the base or the acid the more acid or base needed to make the solution neutral. The mixing should be done as a drop-by-drop titration.
Extension: 11. A molecule is the smallest particle of a substance still having the properties of that substance.	(a) Infer that materials are composed of very small particles.	Review the distinguishing properties of common substances such as ammonia, sugar, chalk. Have students blow onto a cool mirror and identify the condensation on the mirror. Balloons can be filled with perfume and placed into jars. How did the odour move into the jar?
Molecules are made up of smaller particles called atoms.	(b) Infer that molecules of water are made up of smaller particles called atoms. Water is composed of oxygen and hydrogen.	Teacher Demonstration: Electrolysis of water can be done to show that water is made up of hydrogen and oxygen. Put 15 grams of epsom salt into 1 litre of water.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Join wires from cells with a source greater than twelve volts to the leads of two pencils. Place them in inverted test tubes in the solution. Run the current until the water leaves the test tube. Do glowing splinter tests to show hydrogen in one tube and oxygen in the other.
A material which contains only one kind of atom is an element. Materials in which two or more kinds of atoms (elements) are joined chemically is called a compound. Note: Concepts should be introduced only.	(c) Communicate the concept of chemical properties, atoms, and molecules.	Discuss the properties of different elements, e.g., copper, carbon, hydrogen, and oxygen. Compare the properties of carbon, hydrogen and oxygen to the properties of sugar.

Earth, Space, and Time: The Changing Earth

Main Concept: Sedimentary rocks are formed in a number of ways. The structure of sedimentary rocks provides clues to how the earth has changed.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Review from grade 4 (Water and the Land). **Students should be able to:**	
1. Moving water wears away the land and makes rocks smaller.		Social Studies: Have students show where dominant kinds of rocks are located in Manitoba. This requires research and enriches their knowledge of the province.
2. Those rocks which consist of minerals exhibit many structures and properties.	(a) Classify rocks according to structure and the properties of colour, hardness, layering and grain size.	Divide the class into groups and obtain enough rock samples of many different kinds so that there are at least 12 specimens for each group of students. Ask students to sort rocks according to the properties they see. Give them hand magnifiers to use. List on a chart the groups and the common properties. Have them give the reasons for their classifications. Encourage

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		them to order within the properties, e.g., hardness, colour, grain, size. Mines, Resources and Environmental Management (Rock Sets). *Conservation Comment*, July, 1976, Mineral Resources Division, "Common Rocks in Manitoba".
	(b) Observe the process of crystallization and discuss how this relates to mineral growth in nature.	Have students grow their own crystals: Fill jar with hot water, add Borax a little at a time and stir until no more will dissolve; let settle and pour clear liquid into new jars; tie a weighted thread (use thumb tack) to a pencil and suspend in liquid; place jar where it will not be disturbed and observe every day; measure daily. Discuss the formation of stalactites and stalagmites.
3. Some rocks are formed in layers. Those that are laid down in water or on the land are called sedimentary rocks.	(a) Infer order of deposition from layered structures.	Collect layers of lint from the clothes dryer and have students infer the origin and order of the layers.
	(b) Measure the speed of settling particles. Communicate, using graphs, the speed at which particles settle.	Conduct a sinking sand race: Get a tall empty bottle and fill it to the top with clean water; tape a strip of black paper along one side of bottle from top to bottom to help see the particles. and use a strong light and a magnifying glass; drop a pinch of clean sand in the water and watch grains as they sink. Do they all fall at the same speed? Then use different kinds of particles. Time the speed of each size. Graph results. Discuss the variables which may affect the results (size to mass ratio, height of drop).
	(c) Hypothesize on the basis of the previous activity, the order in which rock particles will settle.	Mix sand, pebbles, water, and garden soil in a large jar. Seal and then shake it. Predict settling of particles and subsequent layers. Observe. Note relative sizes of particles in layers. Discuss.
	(d) Infer the process of sedimentation for some layered rocks.	Obtain samples of coarse and fine grained bedded sandstone or use pictures of layered rocks and have students infer their origin. Add layers of different kinds of mud to a jar of water daily to form a model of how layering takes place in sedimentary rock.
4. Sedimentary rocks consist of two main types: those from sediments and those precipated from a solution.	(a) Observe the role of cements in forming some sedimentary rocks.	Make conglomerate with pebbles and glue. (Conglomerate is a naturally formed cement). Have students examine some samples of conglomerates both natural and man-made. Social Studies: Obtain samples of limestone and examine for fossils. This is an opportunity to study glacial deposits in Manitoba. Field Trip: Look for fossils and tracks.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Predict the formation of crystals by evaporation.	Let saturated salt solution evaporate to form rock salt. Examine with magnifiers. Observe rock samples, sand grains in shale, and fossil fragments in limestone using a microscope. Collect samples of man-made bricks and stone for housing facades. Examine and compare. Discuss how they may have been made. The main fragmental kinds are shale, sandstone, and conglomerate. The main precipitate kinds are limestone, salt, and gypsum. Have students make impressions of leaves, shells, water prints in mud, or modelling clay. Take a walk to look for rain prints, foot prints, bird tracks, etc. Examine samples of actual rocks with structures such as layers, rain prints, mud cracks, ripple marks or fossils. Have students suggest how they were formed. Examine pictures if rocks are not available.
5. The structures in some sedimentary rocks help give us clues about their past history.	(a) Infer some of the conditions under which rocks might have been formed.	
6. Fossils are the remains or traces of plants or animals in sedimentary rocks.	(a) Simulate fossil formation and infer change on the basis of fossil evidence, how plants and animals have changed over the years, and what ancient climates were like and how they have changed.	Mix plaster of paris and water and have the students simulate "fossil" impressions of objects they wish to preserve for the future, e.g., pennies, toys, leaves, bones, nuts, etc. Coat the outside of an object with vaseline and then press into the plaster. Let it stand and then remove the original article to leave the imprint. Make a prehistoric diorama with dinosaurs and vegetation. Go on a fossil collecting trip or visit the museum. Compare fossils with modern specimens. Compare past climates (from diorama) with present-day climates. *Extension:* Discuss why fossils are found only in sedimentary rock.

Earth, Space, and Time: The Earth in Space

Main Concept: People use the regular motions of the earth to measure the passage of time.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. One day is the time required for the earth to complete one rotation.	(a) Infer that the rotation of the earth causes day and night.	Shine the light from a projector on a globe in a darkened room. Rotate the globe slowly counter clockwise looking down on the north pole. Find specific locations on the globe and note when they turn into the light (sunrise) and out of the light (sunset). Discuss this activity in terms of day and night.
	(b) Infer the direction of the rotation of the earth.	Note the approximate locations on the horizon where the sun rises and sets. Discuss observations and confirm inferences by relating to globe and light activity above. Using the globe and light, students identify locations which are in daylight while they are in darkness.
	(c) Operationally define one day.	Locate the shadows of a permanent object which may be conveniently observed daily. The position of this shadow is noted at exactly the same time each day for a few days. Discuss observations and have students write a definition of one day in terms of what they have discovered. Note: Often a cardboard shape placed on a sunlit window will provide a good shadow for this activity.
2. An object which changes its position relative to other objects has moved.	(a) Infer that the motion of an object may be detected by comparing its position with other objects.	Observe a small circle on an otherwise blank blackboard. Students cover their eyes while the teacher erases the circle and draws another in a different position. Observe the second circle and discuss whether or not its position has changed. Teacher should guide discussion toward comparison of the positions relative to other objects. Observe a distant moving object, e.g., traffic, birds in flight, airplanes, and discuss how students know the object is moving.
	(b) Infer that an object which appears to have moved may not have moved at all.	Observe a small circle inside a large square on blackboard. Students close their eyes while the teacher erases and redraws the square with the circle still inside. Students discuss what has moved.
	(c) Infer that a changing point of view may cause the illusion of motion.	Close the left eye. With the right eye sight a distant object over the point of a pencil held at arms length. Open the left eye and close the right eye. Discuss observations. What has moved? Tape a square outline on a classroom window. Observe the outdoors through the taped square and have students note

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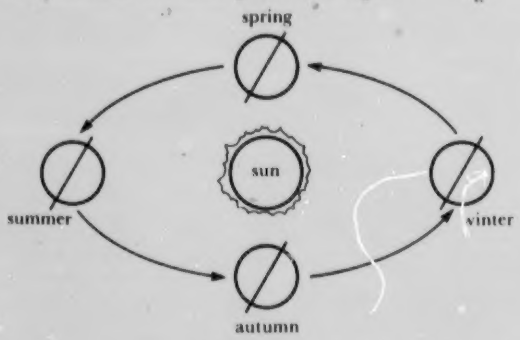
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		how their view changes as they move around inside the classroom.
	(d) Infer how shapes may change when viewed from the opposite direction.	Each student prints his/her name in block letters the way it would look from the other side of the paper, e.g., "BOBBY" would be "YꓭꓭOꓭ". Look into a mirror and wink with the right eye; observe the image winking with its left eye. Answers to this problem may be checked by printing on [illegible] acetate and viewing from the other side.
	(e) Infer that when one object is moving faster than another object, the slower object may appear to be moving backward.	Discuss the effect of passing a car on the highway. Passengers in the slower car appear to move backwards when compared with the observer. This effect may be demonstrated by a student running past another student who is running slowly.
	(f) Hypothesize that the earth or the sun must move.	Observe the passage of the sun across the sky during one day. Suggest different explanations for this motion. Caution: Students should be warned never to look directly at the sun.
3. One year is the time required for the earth to complete one revolution.	(a) Compare rotational motion to revolutionary motion.	Spin objects such as balls, pennies, or tops. This type of motion is defined as rotation. Students then tie objects such as pencils or small weights to a string about one metre long. These objects are then swung around the students heads. This type of motion is defined as revolution. Stand on one spot, then rotate. Then walk (revolve) around the classroom.
	(b) Infer that the axis of the earth is tilted.	Collect sunrise and sunset times from newspapers from various times of the year. From this information, the hours of daylight thoughout the year can be graphed. From the graph, students should conclude that in Manitoba we receive less sunlight in the winter than in the summer. Try to explain why this occurs using the globe and light model. Discuss the summer "midnight sun" and "noon darkness" in the polar regions and relate this to the tilt of the earth's axis. Students should be able to demonstrate how the tilted axis determines the amount of sunlight.
	(c) Observe the area lighted by direct rays and slanted rays. Compare the areas lighted.	Shine a projector light on a vertical paper about one metre away. Repeat this procedure with the paper tilted at about 45° away from the projector. Students should note that the slanted paper is lit over a larger area.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(d) Infer that slanted rays of sunlight produce less heat on the earth than direct rays.	Discuss the fact that the sun is never as high in the sky during the winter months as it is during the summer. Since the heat must be spread over a larger area (because of slanting rays) the winter months are colder. Should repeat above activity using the globe instead of paper.
	(e) Infer that the days of longest daylight relate to the position of the earth in its orbit where the axis leans toward the sun.	Draw the diagram below and demonstrate each of the four seasonal positions with the globe and light.  Note: Seasonal characteristics would be reversed in the southern hemisphere.
	(f) Infer that the revolution of the earth around the sun causes seasonal change.	Discuss seasonal change and hypothesize what type of movement of the earth could account for it. Note: This concept is difficult to demonstrate in the classroom and must be confirmed over time by other activities in the unit.
	(g) Operationally define one year.	Discuss where in the earth's orbit the solstices and equinoxes occur. Write a definition of one year in terms of what has been discovered.
4. Many objects and events in space have unique and exciting characteristics.	(a) Observe through pictures, films, filmstrips and other media the objects and events of near and distant space.	Teacher guides student research of the sun, the moon, the planets, comets, meteors, stars, constellations. Students may wish to build models of the earth—moon system, the solar system, the galaxy. Students may wish to read or write stories about spaceships, space travel, the origin of the Universe. Students may wish to observe, with or without telescopes, the moon, a comet, meteor shower, the constellations. Note: Because of the extremely abstract nature of astronomy, students should not be expected to develop all of the concepts related to the suggested topics.

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Extension Unit:

Cells and Organ Systems

Main Concept: The cell is the basic unit of structure and function in living organisms.

[illegible]izational Framew[illegible] Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. A complex structure is made up of smaller parts.	(a) Operationally define a system as many parts working together to do a particular function.	Introductory Activity: Discuss materials required to build a house and the function of each. Construct a simple diagram showng the various systems within the house, i.e., electrical, heating, etc.
2. Each part of a complex structure has a function. Many parts must work together for the structure to function.	(a) Observe a structure by means of a diagram.	Use an overhead transparency of the human body, showing the various organs and systems. Compare its structure to that of a house, e.g., small part is called a cell which joins with other cells to form tissues, organs, and systems. Discuss (briefly) the function of the various systems.
3. All living organisms are made up of cells.	(a) Observe using a microscope and record observations.	Microscope 40 to 100 power: Begin with a low power experiment, focussing on dots on a newspaper. (Note: Students with glasses may have to remove them). This could be set up as an activity centre prior to doing this unit. Cut a slice off of an onion. Peel the skin off and stain the slice with tincture of iodine. Observe. Place tiny piece on a drop of water on a microscope slide. Place a cover glass on it and examine under microscope. Diagram observations. Gently scrape the inside of the cheek with a toothpick. Streak toothpick on to slide. Stain with tincture of iodine. Examine under a microscope and compare with onion cell. Examine a thin piece of chicken skin under a microscope. Display pictures of nerve cell, skin cell, muscle cell. Discuss their various functions. World Book: Volume C.
4. Cells have membranes.	(a) Infer that a cell membrane allows some things to pass through it and not others.	Take a hard boiled egg and gently crack the shell. Remove a few pieces of shell and examine the membrane. Discuss how it represents a cell membrane.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Place a raw egg in a bowl of vinegar. The vinegar will dissolve the shell in several hours. Dry the egg and place it in salt. Observe.
5. Plants have cell walls.	(a) Infer that some cells have cell walls for structural support.	Examine prepared slides of cork or wood, (if possible) or make overhead transparencies. Discuss the structure and its function.
6. Cells are composed of a nucleus, a cytoplasm, and a cell membrane.	(a) Observe and identify the nucleus, cytoplasm, and cell membrane of a cell.	Prepare a variety of wet mounts of numerous plant materials. Examine under a microscope. Identify the various parts of a cell. Under a microscope examine a tiny piece of Elodea plant on a drop of water on a slide. Describe the cell structure. Observe chlorophyll, nucleus, etc. Note that plant cells differ from animal cells in that plant cells have walls. Note that plant and animal cells are similar in that they both have a nucleus. Examine cells in a celery stalk that has been soaked overnight in coloured water. Collect some pond or rain water. Examine drops using a magnifying glass or microscope. Record the kinds of pond cells observed.
7. Body cells of a single kind are grouped together to form tissues.	(a) Observe that groups of cells of a single kind form a tissue.	Provide a few samples of fresh young twigs. Pupils peel off each layer and observe how each layer differs. Emphasize that each layer is a group of similar cells called a tissue. Examine blood cells under a microscope. Discuss how this tissue differs from skin tissue. Examine a muscle in a cut of meat or poultry, e.g., a chicken leg muscle, and discuss how it too is a tissue.
8. Cells can reproduce.	(a) Infer that cells are capable of reproducing.	Examine a scabbed knee or arm. Discuss how new skin tissue might be formed. Examine a snake skin. Discuss why a snake sheds its skin. Compare to human cell growth.
9. Tissues are grouped together in structures called organs.	(a) Define operationally an organ. Compare to a tissue or organism.	Using a mirror, examine the various tissues of the eye, e.g., pupil, iris, etc. Discuss how these tissues group together to form an organ.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Have students list other parts of the body that may be organs. Discuss. Dissect a chicken heart to observe the various tissues of which it is comprised.
10. Organs work together to form systems, e.g., respiratory, digestive, circulatory.	(a) Operationally define a system as including organs, tissues, and cells all of which perform particular functions.	Using a plastic model or diagram of the human body, have the students try to discover a body system. Discuss and analyze the systems (respiratory, digestive, circulatory, skeletal and muscular). World Book: Human Body Transparencies.
11. The human frame is composed of bones and is called a skeleton.	(a) Infer that the skeleton is important for protection and support.	Collect examples of assorted bones, e.g., chicken, ham, hallowe'en costume of a skeleton, etc. Examine each to see how the bones are connected to each other. Where might muscles be attached? Examine for size and shape. Discuss the purpose of bones in a body. Music: "Them Bone's Connected to the Thigh Bone . . ." etc. World Book: 2 Human Skeleton Transparency. Examine the bones of a small animal and how they are put together. Compare the bone structure to the actual outline of the animal. Discuss the purpose of the structure. Examine pictures of dinosaur bones and scientists' interpretations of what the animals actually looked like. Why did some have heavy legs or small legs?
12. The skeleton supports the body and helps it move by means of muscles.	(a) Infer that muscles are necessary for movement.	Look at assorted bones. Discuss what would make them move. Could they move by themselves. Imagine a body without bones. What would it look like? Art: Murals of skeletons and blobs. (bodies without bone).
13. The skeleton is composed of bones with joints between them.	(a) Observe two places in the body where there is a hinge joint and two where there is a ball and socket joint.	Have a student sit on table and swing one leg from the knee. Discuss which muscles move. Experiment to see how far the leg can be bent in either direction. Compare knee joint to a door hinge. Bend elbow in either direction. Discuss. Compare to leg joint. Standing, rotate one leg in a circle. Find the joint from which it moves. Discuss term ball and socket.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Rotate straight arm in circle. Find the joint that moves. Discuss type of joint. Make a model with plasticine. Lubricate with water.
14. Cartilage is a firm, slippery material between joints.	(a) Infer the importance of cartilage to movement.	Loosely string together several spools with sponge "washers" between. Flex and bend column to illustrate the cushioning effect of cartilage discs. Hold the bottom spool and bend the others on an angle, touching the bottom one at one point. Staple string onto the sides not touching. Secure at the top spool. Pull the string so that the spools are straight or one on top of the other. Observe what happens. Compare to the spinal column. Discuss how the cartilage protects the bones.
15. Muscles are composed of fibers, and are attached to the bone by tendons.	(a) Observe that muscles are made of fibers and are attached to the bone by tendons.	Examine pieces of wool and string under a magnifying glass. Discuss the composition of their fibers and compare it to that of a muscle. Examine the muscle of a chicken leg. Note the tendons which connect the muscles to the bone.
16. Muscle movement is caused by contraction and relaxation of muscles working in pairs.	(a) Observe muscle movement.	Place one hand on the opposite upper arm. Flex the arm. Observe what happens to the muscle. Discuss. Tape a ruler vertically to a desk. Tie a string around the top with the ends on each side of the ruler. Pull both ends simultaneously and equally. Observe. Pull only one end. Observe. Compare to pairs of muscles in the arms and legs. Tie eight long strings to a pencil. Have one student hold each string, pulling it taut. Have the students try to write. Observe. Pretend to write holding a pencil. Observe which muscles move.
17. Muscles are both voluntary and involuntary.	(a) Define operationally voluntary muscles and muscles which cannot be controlled (involuntary).	Find the pulse. Think of something relaxing to try and slow it down. Hold breath for about half a minute. Take pulse before and after. Discuss which muscles can be controlled and which cannot. Discuss why it is better for the heart muscle to work automatically.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
18. The nervous system carries impulses received from the sensory organs to the brain and from the brain to other systems. Some impulses are directly received by other parts of the nervous system.	(a) Infer that movement is controlled by impulses from the brain. Define operationally as reflex actions those responses that are not controlled by the brain.	Students form a row, holding hands. The first one in the row holds a stop watch. When the student starts the watch he/she squeezes next person's hand and so on down the line. (Keep eyes closed). Last one calls stop. Check time. Compare this system to how the brain controls body movement. Experiment with variations. Stand in front of a door that is closing towards you. What do you do? Note: This introduces the idea of a conditioned reflex. Clap hands in front of a partner's face. Can the partner keep from blinking? Blinking is a reflex action. Sit on a table and cross legs. Partner gently taps on the top leg just below the knee. Observe. Is it a reflex action?
19. The sensory organs provide the nervous system with impulses which enable us to react to objects and events.	(a) Observe objects and events using the five senses.	Have the students pinch their noses while sucking on a gumdrop and observe the taste. Sit in the centre of the room. Close eyes. Snap fingers in various parts of the room. Point to the origin of sounds. Blindfold a student. Give the student numerous articles to feel and identify. Let the student identify a series of articles by smell only. Caution: Taste and smell should be used only to test known substances which are nontoxic.

Grade Six

Grade Six

The grade six program is based on three themes taught in five units. These are:

Theme 1 **Interdependency and Interaction among Organisms**
  Unit 1 Interaction of Populations With the Environment
  Unit 2 Changing and Preserving our Environment

Theme 2 **Changes in Matter and Energy**
  Unit 1 Forces and Machines
  Unit 2 Electric Charges

Theme 3 **Earth, Space, and Time**
  Unit 1 Weather

The above units constitute the core of the program at this grade level. Some extension topics and/or extension objectives have been suggested. A sequenced statement of core concepts and processes is found in the scope and sequence chart on pages 39-61. Recommended curriculum materials are compared on page 20 of this guide. Although not all of the recommended curriculum materials will be found in a given school, teachers are advised to acquire those which are compatible with their teaching style. Correlation of the curriculum materials with the core units is provided on the following page.

Teachers should read the section entitled ***Process Development*** which begins on page 13 and continues to page 15. This section provides a clear description of the processes of science which are the focus of this guide. Evaluation of pupils in terms of process development can be done in a variety of ways. Specific recommendations and suggestions for evaluative instruments are given on pages 23-26.

Grade Six

Recommended Materials

UNIT	STEM	MAPS	SCIENCE	SC 5/13	ESS
Interaction of Population with the Environment	6	6	6		
Changing and Preserving Our Environment	6	6	6	Coloured Things	Pond Water Brine Shrimp
Forces and Machines	6,5	5	5		
Electric Charges	6	4	6	Children, Plastics, and Metals	Batteries and Bulbs II
Weather	6,5	6,5	5	Early Experiences	
Extension Unit Light	5,6	6,4	4	Like and Unlike Tackling Problems: Part III Coloured Things	Optics Mirror Cards

Supplementary Reference Section

UNIT	EDS	EYE	ESSP	SCIENCE IN ACTION	SPIES	EXPLORING SCIENCE	SCIENCE: UNDERSTANDING YOUR ENVIRONMENT
Interactions of Populations with the Environment	Oaks, Acorns, Climates and Squirrels Change in a Small Ecosystem		F		Plants and Animals		
Changing and Preserving our Environment	Change in a Small Ecosystem Brine Shrimp and their Habitat Fish and Water Temperatures Man's Habitat—the City	Dandelions Ecology in Your Community	F		Plants and Animals Ecology	6	6
Forces and Machines							5
Electric Changes			F			5	
Extension Unit Light		Your Senses			Light and Sound		
Weather	Snow and Ice	Snow and Ice Mini-climates			Earth Weather		6

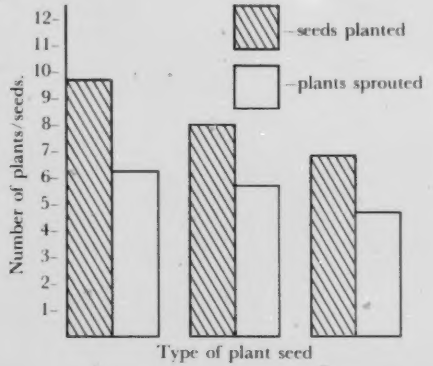
Grade Six

Interdependency and Interaction among Organisms: Interaction of Populations with the Environment

Main Concept: Populations interact with each other and with their environment. Structural and behavioural adaptations enable populations to survive in their environment.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Green plant populations are classified as producers.	(a) Classify various kinds of seed, calculate the amount of each type in a box, and estimate the number of potential plants of each kind.	Measure 30 ml of hamster or gerbil seed. Classify each type of seed and try to match it to its name on the package. Count the number of seeds of each type and record. Calculate or measure the number of seeds in the package. Estimate the number of each type of seed in a package.
	(b) Observe producers during growth.	Plant 30 ml of birdseed in damp soil. Observe (six weeks to grow). Discuss plant requirements and their production of food. Note: Count number of each type of seed and record. Retain for later use.
2. Common organisms can be classified as first, second, and third-order consumers.	(a) Classify organisms as first, second, and third-order consumers.	Present pictures of a plant (e.g., corn), a plant-eating insect, a herbivore, an insect-eating bird, and a carnivore. Ask the students to decide which organisms eat which, i.e., plant, herbivore, carnivore, sequence. Introduce terms first, second, and third-order consumers. Have students suggest other procedures and consumers and classify them. Discuss conclusions that can be drawn from this exercise regarding the interaction of populations with their environments.
3. Human populations are consumers.	(a) Measure the total weight gained by a person since birth.	Determine student's age in years, months, and days. How many days has the student interacted with the environment? Record weight at birth in metric units. Record present weight in metric units. Calculate weight gain. How does the student account for weight gain?
	(b) Measure the daily average weight of food consumed in a twenty-four hour period for one student.	Using a gram table counter, have students estimate the amount of food consumed in a twenty-four hour day. Keep a record of food consumed in a twenty-four hour period. Calculate the total. Compare the total to the estimate. Keep a daily record for five days. Calculate the daily average.
	(c) Predict the weight of food consumed in a ten-day period for one student.	Students predict the weight of food they will consume in a ten-day period by estimating and then by checking their

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		predictions from actual records. Math: Calculate lifetime food intake for class. What conclusions can students draw from this data? See Encyclopaedia. Nutrition: Using UNESCO statistics, compare the food intake of populations in underdeveloped countries with that of populations in better-developed countries. Does this suggest any implications? See Encyclopaedia.
	(d) Measure the weight of the lifetime food intake for one student.	Multiply student's age in days by his or her average food intake per day:
4. The human population is growing rapidly.	(a) Value: Discuss the implications of an increased population on the environment and on individuals.	Discuss the following topics: – attitudes towards crowds; – impact of increased populations on the environment and individuals, e.g., animal life in relation to built-up cities; – changing plant populations in relation to man. Media resources such as crowd pictures, films, etc., may be used to introduce session.
5. Most living organisms produce more offspring than their immediate environment can support.	(a) Infer that abundant seed production increases the possibility of the survival of the species.	Count the number of seeds on a dandelion or sunflower head. Calculate population after three generations if 100% survive. Mathematics: Multiplication.
6. Populations compete for the things they require to sustain life.	(a) Infer that plant populations compete for factors such as food, water, and sunlight, all of which influence their growth.	Dig up some dandelions and then plant them to see if roots and blades will reproduce. What factors determine their growth? Suggest experiments to support the theories put forward. Determine the enemies of dandelions. Determine those plants with which dandelions must compete for their requirements. Other competing plant populations include trees and grass, crops and weeds. Discuss factors for the success of plants such as thistle, tulips, and clover, and for the failure of such plants as the tomatoes, begonias and geraniums. Emphasize competition in the environment. Manitoba Nature: Manitoba Naturalists' Society.
7. Adaptations such as leaf width, root type, and height may aid a plant population's survival.	(a) Observe and record on a graph the number of plants sprouted in relation to the number of seed planted.	Examine bird seed planted earlier. For identification purposes, provide pictures of plants that were expected to sprout. Count the number of each type of plant that sprouted. Record both the number of seeds planted and the number of seeds sprouted. Mathematics: Calculate the ratios of seeds planted to seeds sprouted.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Interpret data collected and infer possible reasons for the success of a plant.	From the previous activity select the plant which was most successful. This may be done either by considering the seeds planted in proportion to the plants sprouted or simply by observing which type of plants had the most sprouts. Examine all the plants in terms of leaf width, root type, and height. Determine which of these factors may have aided the most successful plant. 
8. Some animals guard their territory against others of the same species.	(a) Describe the actions of a neighbourhood animal in defending its territory.	Observe the behaviour of a cat or a dog in its territory when it is approached by another of its species. Report to the class. If possible, observe birds that are nesting and their reactions to other birds in their territory. Discuss why some birds are allowed in but birds of the same species are not.
9. Some animals move their territories when conditions become crowded.	(a) Infer that movement to a new territory is sometimes necessary for the survival of an animal.	Discuss animals which move to new territories, e.g., beaver, bees, deer. List factors necessary for their suvival and how these in turn are related to their possible movement. Discuss how animals indicate their territories to other animals of the same species. How do people indicate their territories? Review briefly a predator-prey relationship. Discuss the implications of a decrease or increase of the prey and predator in terms of territorial movement. Present pictures of our crowded world, e.g., beaches, streets, shelters. Discuss the implications of overcrowding with regard to living conditions, e.g., noise, crime, dirt, traffic, pollution, food, shelter, etc., and what action students may take to improve living conditions.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Develop class murals showing over-crowded human populations and some of the effects of this overcrowding. Language Art: Creative stories, e.g., The Year 2050. Health: Stress, drugs. Social Studies: Discuss the depletion of natural resources and possible results (wars).
10. Population density is a measure of the numbers of plants or animals in a given unit area.	(a) Measure population density in a given unit area.	Count the number of plants or animals in your classroom. Count the number of plants or animals in several other classes. Compare plant or animal populations per classroom.
11. Human population density (people/unit area) is affected by conditions such as climate, water supply, transportation, power (energy).	(a) Infer factors which affect population density.	Examine photos of various land terrains. Have groups determine whether the areas would be densely populated or not and list the reasons for their conclusions. Examine a map of Manitoba. Observe where the greatest number of cities are located. Compare this map to a topographical map for some indication of land condition. Using this information, formulate hypotheses for the location and growth of the cities. Note: Group projects could be done showing the historical growth of a city such as Flin Flon or Brandon, in relation to its environment.
	(b) Interpret data and develop inferences about the reasons for variations in the population of major cities in the world.	Using an almanac, compare the population densities of major world cities. If possible, compare their growth rate over a period of a decade. Can any conclusions be drawn from this data? World Book: Yearbook.
12. Human population densities can change due to natural or man-made changes.	(a) Infer that natural or man-made factors can cause the population density in a given unit area to change.	Bring in a week's supply of various newspapers. Have students check through them to see if they can locate any items regarding natural or man-made disasters or dangers. Clip out the articles, share them and have groups discuss the implications of the disasters to population density and to future living conditions.
13. Scientific developments have affected food production.	(a) Identify ways in which science has improved food production.	Discuss cross breading of plants and animals, crop rotation, fertilizer use, intensive farming and other methods scientists have developed to improve world food production. World Health Organization Pamphlets are available from United Nations.
14. People tend to change their attitude slowly.	(a) Infer that people form generalizations and are slow to change them when presented with a situation that is contrary to their past experience.	With food colouring, colour a small amount of margarine green or blue and leave another portion as it comes from the package. Place a small amount of each type on crackers. Have a blindfolded student taste the margarine to detect

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		differences. Remove the blindfold from the student and offer him similarly prepared crackers. Which does he choose. Discuss additional reasons that people are reluctant to change their attitudes about eating or living.

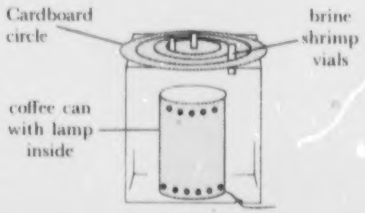
Interdependency and Interaction among Organisms: Changing and Preserving our Environment

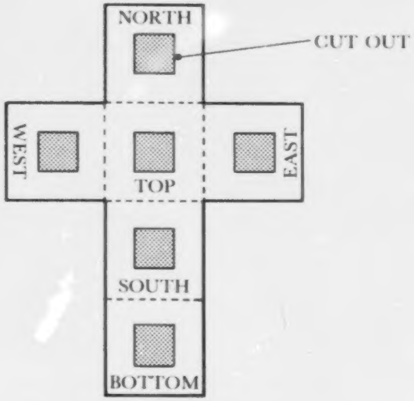
Main Concept: A constant succession of changes occurs within the environment. Changes are dependent upon the interaction of populations, the recycling of materials, and the quality of the environment. Man has a major influence upon the environment.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Living things change.	(a) Observe some changes in living things.	Have students obtain a photo of themselves, parents, and grandparents and discuss changes which have occurred and those aspects which have not changed. Place a cardboard on a small area of grass and observe changes in the grass daily, for a few days. Each student brings a baby photo (labelled in pencil) on the back. Have students try to guess the identity of each baby. Language Arts: Have the students trace their ancestoral roots. Have students write an autobiography. Discuss how they have changed since early childhood and what changes may occur until adulthood.
2. Changes in species can be inferred from fossil evidence.	(a) Infer that species have changed over long periods of time.	Present pictures of the elephant, horse, tiger, shark, and compare these photos to primitive species of the same animal, e.g., mammoth, sabre-tooth tiger, small horse, shark. Discuss what evidence scientists have that such animals existed and discuss reasons why changes have occurred. Museum of Man and Nature: Earth History Gallery.
3. Living things survive when they adapt to changes in their environment.	(a) Infer that plants have adaptations which help them survive changes in their environment.	Discuss adaptations which help grass survive constant mowing. Locate a lawn with a dandelion population. Select one plant and cut it down completely. Mark the spot with a marker with the date on it. Observe over several days. When observation period is completed, dig up the whole plant and examine its root. List adaptations of the dandelion.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Plant a broad-leafed seed (bean) and a grass seed. When grown to 15 cm, notch stems at 1 cm intervals. Observe growth. What adaptations does each have? Pull a grass stem apart. Examine a telescopic section. Observe. Discuss. Walk to a local park. Identify plants as annuals or perennials. List and discuss their adaptations.
	(b) Infer that animals have adaptations which help them survive changes in their environment.	Discuss colouration changes in animals which have evolved as adaptations to their changed environments (i.e., fawns and penguins). Review camouflage (Grade 3 "Populations").
4. Some living things have adapted to man and some have been endangered by his actions.	(a) Infer that man has influenced the survival of some living things.	Discuss organisms (birds, insects, animals) that have adapted to man-made environments, e.g., spiders, mice, gulls. Discuss organisms that have been endangered as a result of man's influence on the environment (loss of habitats), e.g., passenger pigeon. Collect information regarding endangered and extinct species. (Bald eagle, prairie chicken, whooping crane). Build a bird house and put it in an accessible location. Observe the various animals which make use of it. Discuss observations. Language Arts: Have students do research projects on endangered species. The projects might include areas such as the animal's former habitat, the animal's present habitat, reasons for its becoming an endangered species (overhunting, loss of food), what, if anything, is being done to protect the animal.
	(b) Measure the change in mass of a given plant as it grows.	Plant a seed in a container of soil. Measure the mass. Water regularly until the plant is about 15 cm tall. Dry the plant and soil completely. Measure the total mass. Compare the different masses. Discuss what has occurred to cause the change in mass.
5. Non-living material on the earth is recycled, e.g., water.	(a) Operationally define the water cycle.	Using the students' prior knowledge of condensation and evaporation of water, have them make suggestions on how water is recycled. Discuss the desalination of sea water.
	(b) Observe the water cycle in a closed terrarium.	Cover a terrarium with plastic wrap and observe. Discuss the water cycle within the terrarium.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
6. The living and non-living parts of an environment make up an ecosystem. The parts are interdependent.	(a) Operationally define an ecosystem as being several different populations interacting with each other and their environment.	Present a number of pictures displaying ecosystems, e.g., birds, deer and trees in a forest ecosystem or a freshwater pond ecosystem. Have students identify the ecosystem and its component parts. Art: Create a bulletin board display or paint a mural illustrating an ecosystem.
	(b) Observe and record changes in a small ecosystem over a period of time and make inferences from the data.	Field trip: Identify ecosystems. Record the populations and the environments observed for each ecosystem. Construct an aquarium and/or terrarium or collect organisms suitable for each environment, e.g., insects, small animal. Cover the container with a rubber glove or ballon to allow for gas expansion. Do not uncover. A terrarium can be made in a clear plastic bag or box. Observe. On a weekly basis, record changes in the populations of the above ecosystems. Students can examine and identify variables in the environment which may cause change.
7. Populations are affected by changes in an ecosystem.	(a) Control variables in an artificial ecosystem.	Prepare brine shrimp water: Place tap water in a container and let stand for one day. Add about 30 ml rock salt to 1 litre of water. Put 50 to 100 brine shrimp eggs into a vial of brine. Cap and observe for a few days. After 3 days, count hatched brine shrimp by using a sampling technique. Record data. Compare number of hatched shrimp to number of unhatched to determine a ratio for hatching. Sampling Technique: Place a clear plastic container over graph paper. Pour contents of vial into plastic container. Count shrimp in one square of the graph paper and multiply by number of squares covered.
	(b) Predict the change in the population of an organism when the environmental conditions are changed.	To construct an apparatus to measure the effects of heat, cut a circle (37 cm in diameter) out of stiff cardboard. Draw concentric circles at regular intervals from the centre of the circle. Glue aluminum foil to the bottom side of the circle. Trim the edges. Cut the top off a small cardboard box. Place a lamp with a 25 watt bulb in box. Cover with a coffee can which has had both top and bottom removed and holes punched along the ridges of the top and bottom. Place the circle on top of the box. Place brine shrimp vials in various concentric circles. Record the number of shrimp hatched every day and from which circle they came. Thermometers cound be used to measure heat. (Note: Keep tops on vials). Discuss conclusions.

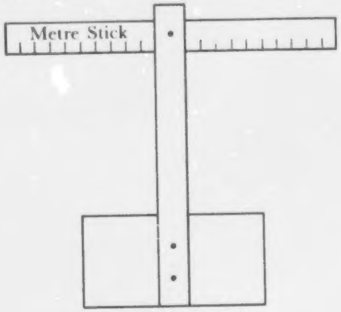
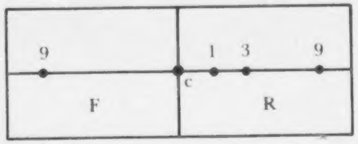
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		 Cardboard circle brine shrimp vials coffee can with lamp inside Note: Brine shrimp survival may also be investigated using varying amounts of detergent, bleach or ammonia. Alternatives to brine shrimp are fruit flies, mealworms.
	(c) Observe and measure population growth in brine shrimp.	Take four vials of equal amounts of brine. Label them A, B, C, and D. Add a small amount of brine shrimp eggs to A and increase the number for each of the others, i.e., D will hold the most. Wait three days. Count the shrimp in each vial for five days. Record hatchings for each group each day. (Shrimp may be fed one grain of yeast per day). Make a graph and interpret the results. Discuss the effects of population over-crowding.
8. Man can affect populations in an environment.	(a) Infer the effects of man's actions on influencing an ecosystem. Interpret data and infer that detergent has a negative influence on a population of algae.	Discuss the ways in which man's actions have caused changes in populations, e.g., dredging of lakes and what effects this has on the ecosystem. Collect algae from a pond. Fill a clean jar with distilled or rain water. Add 5 ml of laundry detergent. Place some algae in the jar with the detergent and some in a control jar. Record observations. Formulate conclusions.
9. Man's inventions may have great impact upon a natural environment.	(a) Classify man's inventions according to the natural resources consumed and the waste materials produced by the inventions.	Have students collect as many pictures of modern inventions as possible. Classify them into groups in terms of natural resources consumed and waste products produced. Discuss how these inventions affect the natural environment.
10. Man influences the quantity and kinds of materials in the air which may affect the environment.	(a) Construct a device to measure the quantity of particles in certain areas. Interpret data and develop inferences about the causes for differences in the amount of dust particles between certain areas.	Construct cardboard cubes and line them with transparent sticky tape, with the sticky side exposed and one side of the cube left open. Place cubes in a variety of areas for a few days. On the cubes, write the location where they were placed. Examine the cubes for dust particles and compare the amounts collected to the environments in which they were placed. Analyze why some containers collected dust

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		more than others. Discuss implications of pollutants in the air.  Have students do research projects on air pollutants. Discuss some of the ways man is trying to reduce air pollution.
11. Chemicals used by man for pest control and improved soil fertility are potentially harmful to the environment.	(a) Infer that chemicals can be harmful to some populations and beneficial to others.	Discuss chemicals which are used to control pests and improve soil fertility. Ask students whether they can locate any information to indicate the effects of these chemicals. Discuss their findings in relation to the environment. *Agriculture and the Environment,* Publications Branch, Manitoba Department of Agriculture.
12. Man must consider steps to improve the quality of the environment.	(a) Value: To be aware that recycling is one method of reducing the rapid depletion of natural resources.	Students collect data on how much paper they use in a week. Estimate the total amount used by the school or community. Discuss methods of disposing of used paper. Discuss the implications the amount of paper used has on the environment. Similar projects could be done with bottles.
13. Man's future will be influenced by his present interaction with the environment.		Determine what changes in population have occurred in your community. Estimate population increases and the implications this will have on your ecosystem. Discuss the environment of the future. Make predictions. Creative Writing: The World Tomorrow, (science fiction).

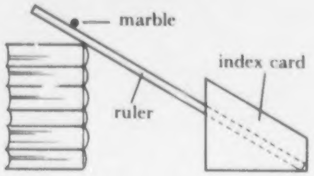
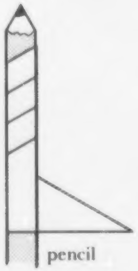
Changes in Matter and Energy: Force and Machines

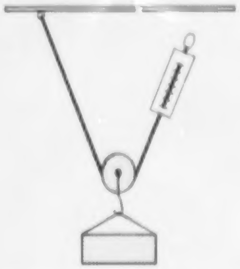
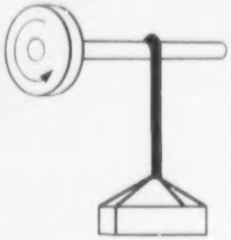
Main Concept: The amount of energy derived from a machine is approximately equal to the amount put into the machine.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
1. Forces act on all things at all times. Forces may change the motion of an object.	Review of material covered in Grade Five, "Forces and Motion". **Students should be able to:**	
2. Several forces may be added to make one large force.	(a) Infer than many small forces may act together to form one large force.	Have one student at a time try to lift a large table with one finger. Next have groups of two students, then three, then four and so on, try until the table is lifted. If the number of students needed to lift the table by using one finger each is twelve, the students should note that their combined force may be about twelve times as great as one student trying to lift the table with one finger. Note: The force will not be exactly twelve times as great, as some students will exert a greater force with one finger than others. This experiment may be modified by having one student try to push a heavy object. Keep adding students until the object can be moved.
	(b) Observe that several threads can exert more force on an object than one thread.	Wrap one piece of thread around a heavy object. The object must be heavy enough to cause the thread to break. Add more pieces of thread, one at a time, until the object can be lifted without the threads breaking. The students should infer that the force transmitted by the threads against the object is greater than the force applied by one thread against the object.
3. An object with a small surface area will fall more quickly than one with a large surface area (air resistance).	(a) Observe that an object with a smaller surface area will fall more quickly than the same object with a large surface area. (b) Graph the relation of surface area to rate of fall.	Take two identical sheets of paper. Crumple one up and leave the other flat. Drop them from the same height. Note that the crumpled paper falls directly to the floor while the flat piece flutters down lazily. Smooth out the crumpled paper and crumple the flat paper. Repeat the drop. Graph the results.
4. The amount of force acting on one square unit of surface is called "pressure".	(a) Infer that a force exerted over a small area exerts a greater pressure than an equivalent force exerted over a large area.	Have students trace their shoeprints on a piece of graph paper. Have them trace their heel print. Have the students calculate from the graph paper how much surface area both feet, one foot, and their heel covers. Then take the students outside and have them stand in a sand pit or in loosely packed snow. Have the students stand on two feet, then one foot, then one heel. Measure the depth each sinks. Have students stand on a snow bank first with snowshoes, then without them. How far do they sink each time? Discuss. Note: This will not work in a snow bank or deep snow.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
5. A wedge is a simple machine that changes the effect of an applied force.	(a) Observe the effects of a wedge in action.	Have the students hold pencils vertically with the eraser resting on a piece of cardboard. Have the students apply downward force to the pencil. Repeat with the lead end of the pencil. Try to apply the same force. Note which goes further into the paper. Hold a flathead nail with the head resting on a block of wood. Hit the point of the nail squarely just once. Repeat with the tip of the nail resting on the wood. Try to use the same force and hit the nail once. Caution: Students should not hit the nail too hard as it may fly off the block and strike someone.
6. A wedge changes the direction of an applied force.	(a) Observe that a wedge changes the direction of a force. Operationally define a wedge.	Push a wedge under a book and note that the book moves up. Define a wedge as a simple machine which changes the effect and direction of the force. All simple machines will fit this generalized definition.
7. Levers change both the direction and effect of forces. The distance a force is moved by a lever depends on the location of the pivoting point (fulcrum). The amount of force that can be applied through a lever depends on the location of the force and load in relation to the fulcrum.	(a) Construct a lever.	Levers can be made in the following ways: Drill a hole through two boards and the centre of a metre stick; run a bolt through the three holes; attach the two boards to the base and place cup hooks on the underside of the metre stick at the 0, 60, 67.5, 75, and 100 cm marks.  OR Use heavy, rectangular cardboard 20 cm long and 4 cm wide; punch holes at 1, 10, 11, 13, and 19 cm from one end and label the holes. 

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Observe and record the effect that the location of the fulcrum of a lever has on the distance each end of a lever moves.	Use a pencil or thin dowelling as a fulcrum. Place the fulcrum at the 0, R1, R3, and R9 positions. Record and compare the distances each end moves.
	(b) Infer that the relationship between balanced input and load forces on a lever is dependent on their location relative to the fulcrum.	Using the metre stick lever, students can balance the forces by using a constant 10 g force at the 0 marking in conjunction with masses at other points on the lever, i.e., balance a 10 g force with 10 g at the 100 cm mark, then balance 10 g with 20 g at the 75 cm mark. Vary the force at the 0 marking and balance. Record the results. OR Use the cardboard lever made for the previous activity, and washers and paper clips to hold them. Balance one washer placed at the F9 position by adding washers at the R9 position. Repeat for other positions, e.g., R3. Increase the number of washers at F9 and repeat the activity. Record results and compare the relationship between balanced sets of forces and the locations of forces relative to the fulcrum. Note: "F" could refer to input force and "R" could refer to load or resistance.
	(c) Predict the forces that will balance a lever with an off-centre fulcrum.	Punch an additional hole in the cardboard lever at 14.5 cm with the fulcrum at R 14.5. Students are to predict the number of washers required to balance one or more washers placed at the F 9 position and to balance the system.
8. The amount of force required to pull an object up an inclined plane is less than the amount of force required to lift the object.	(a) Infer that an inclined plane decreases the force required to lift an object. Identify the control and experiment with variables that affect the forces needed to move an object up an inclined plane.	Stack several textbooks on top of one another. Run a board or a textbook to the top of the stack. Pull an object up an inclined plane at various angles. One of the angles should be 45°. Record the results and compare the forces needed with the force needed for the straight lift. Cover the inclined plane with very coarse sand paper. Pull the object up at the same angles as before. Compare the forces needed to pull the object over the rough surface with the forces needed to pull the object over the smooth surface. Fold an index card and cut it at an angle. Use a ruler with a groove running down the centre to make an inclined plane. Place the open side of the index card at the base of the inclined plane.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Control the variables of release point and angle of an inclined plane. Observe and compare the forces a marble exerts on an index card. Record and interpret the data.	 Release a marble from various points on the ruler into the index card. Record each release point and how far the index card moved. Alter the angle of the inclined plane and release the marble. The students may either measure the angles in degrees or may increase the height of the inclined plane 5 cm at a time. They should record the results.
	(c) Predict the height of an inclined plane required to move an index card a specific distance along a desk.	By referring to their data the students should now be able to move the index card a specified distance in one try.
9. A screw is a spiral inclined plane.	(a) Construct a model of a screw.	Wind a right angled triangle of paper around a pencil to demonstrate the concept of a screw. 
	(b) Compare the holding power of a screw with the holding power of a nail.	Have students bind two pieces of wood together with a nail, then with a screw. Compare the holding power of each.
10. A single fixed pulley changes the direction of the force exerted.	(a) Observe that the force needed to lift an object with a single fixed pulley is equal to the mass of the object, and that the direction of the force is changed.	Set up a single fixed pulley. Lift a 1 kg mass on the pulley using a spring scale. The students will note that their readings are not equal to the mass being lifted. Students may suggest variables affecting the system. Discuss directions of forces.

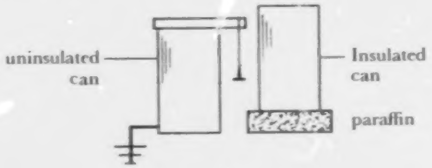
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
11. The force applied on an object can be increased by using a moveable pulley.	(a) Observe and infer that less force than the mass of an object is needed to lift it when a moveable rather than a fixed pulley is used.	Set up a moveable pulley. Use a spring scale to lift an object with the pullery. Note directional changes and relationship between the input force and the load. 
12. A wheel and axle is a simple machine.	(a) Observe wheels and axles.	Observe the different directions of the pedals and the wheels as a bicycle is ridden. Examine common wheels and axles, e.g., door knob, car steering wheel, bicycle. Go on a trip around the school and have students label simple machines that they see.
	(b) Construct a model of a wheel and axle.	Use tinkertoys to construct a model wheel and axle which can lift a weight. 

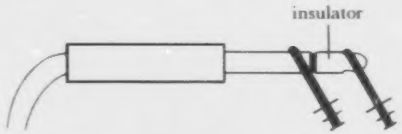
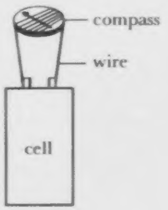
Changes in Matter and Energy: Electric Charges

Main Concept: Electrical energy can be converted into or produced from other forms of energy.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. When some materials are subbed together, they receive an electrical charge.	(a) Observe that a material may become electrically charged if it is rubbed against a material.	Hold a neon glow light and shuffle across the room on nylon or wool carpet. Notice that the glow light lights up. This can also be done with a small fluorescent light. It is very effective in a darkened classroom.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Shuffle your feet across a rug of nylon or wool. Then touch a metal object. Note the shock. Touch the tip of a partner's finger. Touch objects such as wood and plastic.
	(b) Hypothesize that the amount of electrical charge can be increased by rubbing two materials against each other an increased number of times.	Rub a comb or a plastic brush through your hair. See how many pieces of paper you can pick up with it. Try twice as many strokes to see if you can pick up twice as many pieces of paper. Note that freshly washed or clean hair will give the comb a greater charge.
	(c) Design an experiment to stick a balloon to a wall.	Rub a balloon on your hair. Stick it to a wall. Then rub it on your clothes and stick it to a wall. Note by which method the balloon will stick the longest. Repeat using various fabrics.
2. An object that has an electrical charge may attract an uncharged object. An object that has an electrical charge can attract or repel another charged object.	(a) Observe the attraction of an uncharged object by a charged object.	Rub two items such as a sweater and a balloon or a ping pong ball and a plastic bag together. Note that these objects which now have an electrical charge will attract small objects which are suspended on pieces of thread, e.g., puffed wheat, small ball of foil, toothpick, broomstraw.
	(b) Observe the repulsion and the attraction of two electrically charged objects.	Charge an object such as a comb or a plastic spoon. Hold it near a slow-running water tap. Note that the charged object will deflect the flowing water. Have the students vigorously rub a strand of wool with a plastic bag. Suspend the wool over the desk. Hold it in place with a wooden block. Place uncharged objects such as wood, a rubber band, and a feather near the wool. Note that the strand of wool is attracted. Rub the uncharged objects with the same plastic bag. Note that the wool is repelled. Hold five pieces of wool together at one end and let them hang. Then, rub the five pieces and let them hang again. Note that the ends of the wool now repel each other.
3. There are two different kinds of electrical charges: like charges will repel and unlike charges attract.	(a) Infer that there are two different kinds of electrical charges.	Hold two charged strands of wool close to each other. Note that they repel. Hold two charged strands of plastic bag together. Note that they also repel each other. Hold a charged strand of wool and a charged strand of plastic bag near each other. Note that they attract each other.
4. An electrical charge can move from one object to another. This produces an electrical current.	(a) Infer that an electrical charge can be carried from one object to another.	Suspend two balloons from threads about ten centimeters apart. Comb hair with a plastic comb and touch one balloon. Touch the other balloon at the same time with a glass test tube which has been rubbed with plastic wrap. Observe.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		Remove the labels from two large juice cans. Place one on a block of paraffin. Place a block of wood on the other. The can on the paraffin is the insulated can. It should not be touched nor should anyone stand too close to it. The can with the block on it is the uninsulated can. The uninsulated can should be hooked up to a water tap by means of a long insulated wire which is bare at each end. Hang a tack on a string from the top of the uninsulated can. Rub a plastic bag with wool and touch the insulated can with the plastic bag. Repeat five or six times. The tack will be attracted to the insulated can. When it touches it, it will gain an electrical charge and move back to the uninsulated can. The charge will be drained off and the tack will again be attracted to the insulated can. As long as the insulated can is charged with electricity the tack will move back and forth. 
5. An electric charge can move through a conductor to produce an electrical current.	(a) Observe the effects on an electrical charge of joining two insulated objects of different charges. Predict and verify the kinds of material which can carry an electrical charge.	Place another insulated can a metre away from the original insulated can. Join them with a thin wire. Touch the third can with a plastic bag as above. Observe that the tack will move back and forth. Test this system with aluminum foil, wet string, and string that has been soaked in a salt solution. In another experiment, students can join a bulb to insulated and uninsulated cans. The insulated can is repeatedly touched with a charged plastic bag.
6. An electrical current can be produced by chemical means.	(a) Observe that two different metals can produce an electrical current when they are placed into an acid or a salt solution.	Place a thin sheet of zinc and a thin sheet of copper in a weak acid solution of vinegar or lemon juice. Attach the bare ends of copper wire to the two metals and run these wires to a flashlight bulb to make a circuit. The electrical current produced by the metals and solution should light the bulb. Try this again using water and salt, and water and sugar. Try different metals. A current too weak to light the bulb may be formed. It can be detected with earphones or a speaker from a radio. If the jack of the earphones is touching the wires as shown in the diagram, a click will be heard when

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		the circuit is completed or broken if electricity is flowing through the circuit.  Lay a sheet of clean copper metal on thick newspaper. Place a few paper towels on the copper so that it is almost completely covered. Carefully pour a solution of salt and vinegar on the towels until they are soaked. Place a clean sheet of zinc metal on top of the vinegar and slat soaked towels. The zinc must not touch the copper at any point. Use a mini socket to hold a flashlight bulb. Connect one wire from the socket to the copper. Connect the other wire from the socket to the zinc. The bulb will light up. If no zinc is available use a piece of galvanized metal. The apparatus should be taken apart and washed thoroughly.
7. An electrical current can be detected with a magnet because an electrical current exhibits magnetic properties.	(a) Infer the presence of electrical currents by testing with a magnet.	Wrap a magnetic compass with about twenty turns of insulated wire and connect to a cell as in the diagram.  Note: Maximum deflection occurs when the compass is wrapped with coils parallel to needle. When an electrical current flows through the wires the needle of the compass will move. Test for the presence of an electrical current in the following cells: —a vinegar soaked blotter placed between a penny and a paper clip; —a wet cloth sprinkled with baking soda placed between an aluminum pan and bunched up copper wire; —a piece of paper towel soaked with lemon juice and placed between a strip of zinc and a strip of copper; —a galvanized pail lined with cloth, and copper screening placed against the cloth. Fill the pail with a salt solution.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
8. When an electrical current is passed through wire that is coiled around certain metals, the system will become an electro-magnet.	(a) Construct a simple electro-magnet and hypothesize that an increase in the number of coils increases the strength of the electro-magnet. Design an experiment to test the hypothesis that an increase in the number of coils around the metal will increase the strength of the electro-magnet.	Wrap five coils of insulated wire around a large iron nail. Connect the wire to both terminals of a dry cell. See how many tacks or paper clips it can pick up. Caution: Disconnect immediately after use. Repeat using, 10, 15, 20, 25, 30, and 35 coils. Each time record the number of tacks or paper clips picked up. Make a graph to show your results. Control all variables except the number of coils of an electro-magnet. Note: This activity can be extended by controlling other variables such as thickness of wire, strength of cell, size of nail, composition of nail. *Extension* Hook a doorbell up to a cell to study the electro-magnet's function in this device. Examine practical applications of electro-magnets: telegraph, telephones, burgular alarms. Demonstrate induction using activities 4c and 5a. Discuss practical implications of induction, e.g., lighting rods.

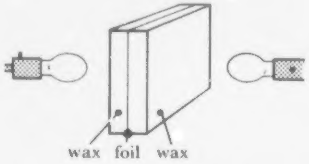
Extension Unit

Light

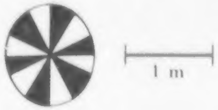
Main Concept: Light is a form of radiant energy. Light tends to travel in straight lines and is reflected or refracted by some materials.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. An object may be seen when it reflects light.	(a) Infer that an object can be seen when it reflects light.	Station students in a dark room. Shine a flashlight. Shine it again after chalkdust has been dispersed in the room. Make a dark box. Line a shoebox with black construction paper or spray paint it black. Open it in a dark closet or larger dark cardboard box and look into it.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	(b) Observe the angle at which light is reflected.	Place two mirrors in such a way that a beam of light in a dark room will reflect from one mirror to the other and then light up a spot on a screen. Now arrange a single mirror so that light reflects from it to the now-visible screen. In a dim room, use two blocks to form a slit. Shine a flashlight through the slit onto a mirror. Notice where the beam hits the wall. To study infinite reflection, place two mirrors so that their faces are pointed at each other. Make a pin hole in the back of one mirror. Make a circle with china marker or black felt pen on the face of the same mirror directly around the pin hole. Look through the pin hole to see multiple reflections of the circle. The mirrors can be stood upright by using plasticine for a base. Note: To make a pin hole, scratch off a small part of the silvered section of the mirror.
	(c) Design an experiment to show that objects can be seen when they reflect light.	Make a peep hole in a covered box. Put an object into the box. Look inside. Poke another hole in the box. Look inside again. The object is now visible.
2. Light travels in a straight line.	(a) Observe that light does not travel around corners.	Use straws or rubber tubing. Slowly bend them up, down, and sideways. Notice when you no longer have a field of view. Punch holes in the centre of four index cards. Look at a small light source, e.g., one small bulb. Move all or any of the cards. See if you can still see the light source. One student shines a flashlight against an object. Have students go around a corner to see if they can still see the light.
3. Some objects can be seen because they produce their own light.	(a) Observe objects that are light sources.	Observe a match, a candle, and an electric light. Note that you can see the light they produce.
4. Light sources, direct or reflected, vary in intensity.	(a) Observe the brightness of various light sources and infer that the intensities of light can differ.	Use a photometer or a light meter to read the intensity of various light sources. Make a simple photometer with which to gauge the intensity of various light sources. Use two blocks of para-

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		ffin, two rubber bands, and a sheet of foil paper. Fold the foil with the shiny sides on the outside and put it in between the two blocks. Bind the blocks together with the rubber bands. A beam of light on the first wax block can be matched with a light of equal intensity shining on the other block. The lighter the other block, the brighter the light source. 
5. The colour of an object affects its ability to reflect light.	(a) Control the variable of colour.	Have students observe street signs, reflectors, and colours of various objects during the day. Observe them again at night to see if the colours appear to have changed.
	(b) Order and graph the colours on the basis of light reflection.	Place a yellow card and a black card equidistant from a photometer. Note which side of the photometer lights up the most. Test a number of colours. Rank these colours and make a bar graph.
6. The shape of an object determines the degree to which light will be reflected. Some shapes will concentrate light and some will diffuse light.	(a) Observe how concave and convex objects reflect light.	Hold a pencil in front of a shiny tablespoon. Observe the image when the pencil is held in front of and behind the spoon. Hold the pencil at various distances, from very close to 50 cm away. In a dim room, shine a light source on a concave and convex mirror. Notice which one concentrates and which one disperses light. Chalkdust in the air will enhance the effect.
7. There is an optimum amount of light required to make the focus of an image sharp.	(a) Observe the effect of a pin hole on the focus of an image.	Punch a pin hole in the centre of an index card. Observe a lighted bulb through the pin hole. You can read the printing on the bulb. Make a camera obscura: Use two open-ended tubes, one of which slides over the other (the tube with the larger diameter should be the shortest in length); place a piece of wax over one end of the longer tube and tape foil over the open end of the shorter tube; make a pin hole in the

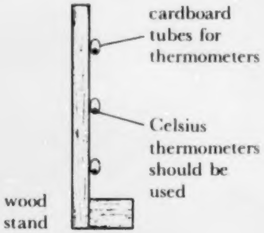
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		foil. Observe objects. Enlarge the hole and observe the same objects. (Wax paper may be substituted for wax).
8. The appearance of an object changes when it is viewed through a drop of water.	(a) Observe the effect on the appearance of an object when it is viewed through various shapes and sizes of drops of water.	Place drops of water on a magazine page. Observe how the letters look.
	(b) Infer the relationship between the size and shape of a drop and the magnification of an object.	Make a small loop at the end of a wire. Place a drop of water in the loop. Observe the magnification of the print. Repeat with a larger loop.
9. A beam of light changes direction as it passes from one medium to another.	Observe that light bends when it passes from air into water.	Place very milky water into a container. In a dark room shine a flashlight at an angle into the water. Have a student place a coin in an empty cup. The coin must not be visible when viewed over the rim. Have another student add a measured amount of water just until the edge of the penny becomes visible. Continue until half and then all of the penny shows. Make a bar graph of the amounts of water used in relation to the amount of coin visible.
10. White light is a combination of the light of all the colours of the spectrum.	(a) Observe the effect on light when it passes through a prism.	Cut a slit in one end and a round observing hole in the other end of a shoe box that has been lined with black paper. Stand a prism in the box so that it is directly in front of the slit. Darken the room and shine a projector light through the slit. Observe the direction of the light through the air and glass. Burning incense or chalkdust will cause the light beam to show up more clearly. Observe the colours of the light coming out of the prism. Repeat the above activity changing the position of the prism and the distance the prism is from the slit.
11. When a beam of light is reflected or refracted in a certain way, it forms a spectrum.	(a) Observe the effect of various solids on the separation of white light.	Look across a record groove, at soap bubbles and at cut-glass jewels. Note the spectrum. Look at a glass of water that has sunlight shining through it. Note the spectrum on the table. Look at oil on top of water in sunlight.

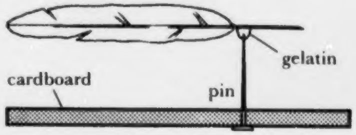
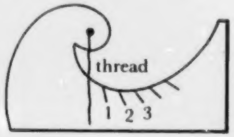
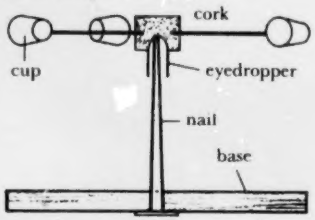
Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
12. An optical illusion occurs when the senses provide evidence conflicting with previous experience. The brain interprets the evidence incorrectly.	(a) Discriminate between ordinary observations and sensory illusions.	Look at a circle that has different sized rays running into the centre. Note how the rays seem to wave or flagellate. 
13. Retinal fatigue occurs from continuous exposure of the retina to light. The retina retains an image and an illusion occurs.	(a) Infer from evidence that some optical illusion result from the retention of an image for a short period of time.	Look at a black dot on a white background. Then look at a white sheet. Discuss observations.

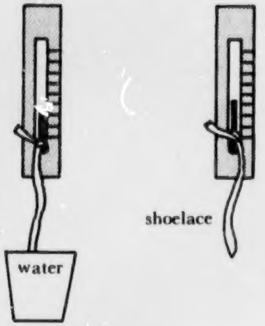
Earth, Space and Time: Weather

Main Concept: Weather, an indicator of the conditions within the earth's atmosphere, is the result of interactions between matter and energy.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
	Students should be able to:	
1. Weather consists of interacting factors such as temperature, pressure, precipitation, humidity, and wind.	(a) Keep records of weather data and relate the data to the type of weather.	Obtaining and recording of temperature (highs and lows), precipitation, winds, humidity, and type of weather should be continuous throughout this unit after students have developed instruments and decided on the position of the weather station. Data may be recorded and inferences concerning the relationship between weather and various factors be made during the development of the unit and/or this data may be used to conclude the unit in terms of relating weather to the data collected. Predictions concerning future weather may be carried beyond the time allotted for the unit or at a time when the students have sufficient background to begin to make predictions. Obtain daily weather charts from the newspaper or the Department of Transport, Meteorological Branch. Instructions for building instruments are also available from the Department of Transport Meteorological Branch. J. A. Konan, *Watching the Weather*. The Macmillan Company, is a good teacher reference.

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
2. Wind is caused by the movement of air masses. Fluids tend to rise when warmed and sink when cooled. Air is a fluid.	(a) Observe that warm fluids tend to rise and cooled fluids tend to sink.	Fill a wide-mouth jar with cold water. Fill a small jar with warm, coloured water and cover the jar with aluminum foil. Bind the foil to the jar with rubber bands. Lower the small jar into the large jar and puncture the foil. Observe. Place your hand above a bulb and then the same distance below the bulb. Compare degree of hotness. Compare the action of chalk dust (clouds) in a projector beam with a hot plate below the dust and without a hot plate.
The motion of air masses is affected by whether warm air overlies cold air (stable) or cold air overlies warm air (unstable).	(b) Predict the behaviour of cold air overlying warm air and vice versa.	Using two identical jars, fill one with cold water and the other with coloured, warm water. Place the cold water container into a pan. Wet a cardboard card on both sides; place it on top of the warm water container and invert and place the container (with care) over the top of the cold water container. Carefully remove the card and observe. Repeat using a cold water container over a hot water container. Apply to air masses.
Heat energy can be transferred from one place to another by convection.	(c) Operationally define convection as the movement of a fluid that accompanies heat transfer. Describe heat transfer in a room by means of convection.	Build a convection box and examine convection currents. Demonstration may be adequate. OR Gently drop crystals of potassium permanganate or drops of food colouring along one side of a warm clear jar and observe, diagram, and explain the flow of colour.
The temperature of air masses is affected by the height above the ground, nature of land surfaces, and other factors.	(d) Measure, record and compare the effects of the position of a thermometer, the colour of soil, and other factors on air temperature.	Record air temperatures at different levels above the ground surface, e.g., grass. Shield the thermometers from the sun. Refer to the diagram.  cardboard tubes for thermometers Celsius thermometers should be used wood stand Test and record temperatures above other surfaces and compare. What factors should we keep constant, e.g., exposure to sunlight? Determine maximum and minimum daytime temperatures. Examine the temperature of soils at different depths and record. Compare south, north, east, and west walled areas. Compare temperatures within (same depth) and above soils of different colours, e.g., cover one plot equally with coal dust, another with white powder

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		(e.g., chalk dust), another with sand, and compare their temperatures to that of the control (regular) soil available. Apply to the effects upon the motion of air masses. If this unit is attempted in the winter, teachers may consider using the wind and temperature activities from *EYE: Snow and Ice* or *EDS: Snow and Ice.*
Winds occur when one air mass replaces another. With unequal heating of air masses, warm air rises because it is pushed (usually up) by colder, denser air.	(e) Measure the speed and direction of wind using student-made apparatus. Infer the direction of air currents. Predict likely directions of air currents within a closed system and the effect on wind of different land and water masses.	Use a feather, straight pins, gelatin capsules and cardboard. Assemble as in the diagram. Make a tiny hole in a gelatin capsule with a pin heated in a candle flame. Push the pin through the cardboard and into the hole in the gelatin capsule. The feather is taped to the gelatin capsule. Test the direction of air currents in various parts of the room. Suggest reasons for air movement.  Make a simple wind gauge from 8.5" x 11" cardboard and thread. Cut cardboard as in diagram and hang thread from the eye. Mark 1 cm marks along the opening. To use, point the device directly into the wind and note where the thread hangs.  Make a cup anemometer using a cork for the centre and paper cups on three rods. Use an eye dropper to support the cork. Nail in the base so it will pivot easily. Measure wind speeds. Time revolutions for known wind speeds (May be used to measure larger differences in wind speeds). Measure wind speed at various locations around the school and record measurements on a map or chart. 

Organizational Framework for Teachers	Objectives	Suggested Activities/Teacher Notes and Integration
		You may wish to review and use some of the hot and cold air balancing activities (Air and Air Pressure—Grade 3). Test the effect of obstacles on wind direction, e.g., around the corners of the school building. Discuss the effect of large bodies of water on day and night breezes. Compare wind speeds at different heights above a surface. Compare the effect of wind speeds on temperature (a wind chill chart could be made over a period of time). Social Studies: Study the positive and/or negative effects weather conditions have on the land mass there they occur. Reports, pictures and any media publications should be used by the students.
3. The direction and movement of air masses will affect local weather conditions.	(a) Describe the effect of wind direction on local weather.	Using weather reports or charts, make comparisons in terms of temperature and precipitation relative to air masses moving into the area.
4. Water absorbs energy when it evaporates and gives up energy when it condenses.	(a) Observe that evaporating water cools an object.	Place a drop of water on one of your hands. Spread the drop out and blow on it. Which hand feels warmer. Place two equal lengths of cut shoelaces around the bulbs of two similar thermometers. Tie just above the bulb, as in the picture. Wet one shoelace with water at room temperature. Keep the other dry. Fan the thermometers for two minutes. Record temperature at thirty second intervals. 
	(b) Observe differences between temperatures within systems where condensation occurs and where no condensation is occurring.	Place a crumpled, wet paper towel and a thermometer inside a closed glass jar. Place the container in sunlight (inside thermometer should be shaded from direct sunlight). Place a thermometer (shaded from the sunlight) next to the jar. Observe condensation inside jar and temperatures of different thermometers. Discuss. Note: Heat energy is trapped inside the jar, both by air and water vapour. Condensation is caused by water vapour contacting the glass jar, which is

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		in contact with cooler air. It is difficult to illustrate heat loss by condensation. Note: A closed system is one which does not allow additional materials to enter the system.
5. Water vapour entering the air in a closed system will increase the forces within the system. Water tends to evaporate until the surrounding air is saturated, i.e., the air holds all the water vapour it can.	(a) Formulate a hypothesis that explains an increase in forces within a sealed jar in which water has been placed.	Tape a thermometer inside each of two glass jars (equal size and shape). Use thermometers which show exactly the same temperature for room temperature (some may vary slightly). Place a cupful of water (room temperature) into one jar. Cover both jars with a tight rubber membrane (balloon with neck removed) and fasten with rubber bands. Compare the tops of containers after a short period of time.
	(b) Infer that a volume of air will hold a limited amount of water vapour.	At the same time, use three additional jars with rubber membranes and thermometers. Place one-half cupful of water in one, one-quarter cupful in another, and an eyedropper full in the third. Label the jars. Observe and compare differences among the tops of the jars. What conclusions can be drawn about the ability of air to hold water? What would happen to the water (not evaporated) in a jar, if the top were removed and why? Note: Since saturation depends on the volume and the temperature of the air, the teacher should test the system initially in order to determine the quantities and conditions.
6. Air holds varying amounts of water.	(a) Measure and record relative humidity over a period of time.	Keep a record of the daily relative humidity in a moist bathroom, the classroom, and outside using the wet and dry thermometers developed in 4 (a) and a relative humidity table. (Relative humidity tables are available in most reference books). Suggest reasons for variations in temperature and in the relative humidity. Keep a record of relative humidity over a period of time. Discuss the ability of warm, summer air to hold moisture in comparison to cold, winter air. Note: Relative humidity refers to the amount of water vapour actually in the air compared to what it could hold at a particular temperature. Air is saturated at 100 percent humidity and contains no water vapour at zero percent. Air is seldom at 100 or 0 percent relative humidity.
7. The dewpoint is the temperature at which water vapour in the air condenses.	(a) Define dewpoint and measure it in the classroom.	Teachers may wish to demonstrate the formation of dew by placing a pitcher with ice cubes in the room. The condensed water can be examined to determine whether dissolved materials are present. It can be compared to evaporated tap water (i.e., the pureness of condensed water vapour). Students can determine the dewpoint by half filling a shiny, metal juice can with water. Add ice, a piece at a time, and stir with a

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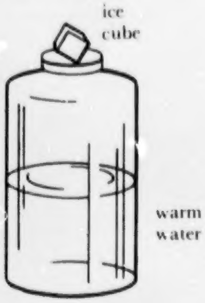
		thermometer. Keep adding ice until condensation first appears. Record this temperature as dewpoint. Compare dewpoints inside and outside the classroom. Discuss why dew forms at night on objects that radiate heat and cool below the dewpoint. Discuss the formation of frost (water vapour condensing on objects below freezing point).
8. Clouds can form when moisture-laden air rises and is cooled. Rain is formed when many small droplets condense.	(a) Demonstrate (model) cloud formation and ways in which clouds and fog can be formed.	Take a one gallon jar and pour about 50 ml of water into it. Cover the jar with a rubber sheet and fasten lightly with elastic bands. In a few minutes strike a match, blow it out, and with a classmate's help, quickly place the smoking match (match is not burning) into the jar and replace the lid. In a minute, press down the cover, for about five seconds and then quickly pull up. Repeat if unsuccessful. Discuss possible reasons for cloud formation, e.g., saturation of air, role of smoke particles, decrease of pressure (cooling effect). Discuss the formation of rain. Fog (clouds near ground) can be formed by using the device illustrated on the right. Note: Darkening the room and shining a beam of light through the jar may help to identify small "cloud droplets". 
	Extension	
	(b) Observe and record different cloud formations.	Using a cloud chart, observe and record the names of daily cloud formations along with weather conditions. Try to predict weather based on cloud formations.
	(c) Construct and calibrate a rain gauge. Record daily precipitation over a period of time.	Make a rain gauge by making a 1 cm hole in the plastic lid of a coffee can. Push the lid down to form a funnel inside the can. The gauge may be calibrated by taping a ruler to the outside and placing indentations at each cm

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387		with a nail. Indentations may be counted on the inside. The recording of daily temperature, relative humidity, cloud formations, precipitation, wind velocities and direction may be conducted over a period of time and used to predict weather or correlated with weather forecasts (see the first page of this unit). A weather recording area may be set up in the school yard. Cloud Chart: Department of the Environment, Canada. Drama: T.V. weather reports. Set up a map for students to use in presenting daily weather reports. Demonstrate a weather report using the map and decide on the necessary content (highs, lows, temperature etc.). Students take turns presenting reports. More complex weather conditions such as hurricane, tornado, can be presented as well 388